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APPRECIATIVE REMARKS ON THE THEORY OF GROUPS.

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While it is clearly impossible for the average high school teacher of mathematics to become familiar with all the modern branches of this subject, it is desirable that he should not be totally ignorant of any extensive branch. The views of a number of eminent mathematicians often furnish one of the simplest as well as one of the most reliable introductions to the nature and the scope of a difficult subject. The following list of quotations has been prepared for the purpose of providing such an introduction for one subject. The list can easily be extended but the variety and the standing of the mathematicians quoted are perhaps sufficient to inspire confidence. The quotations are arranged chronologically beginning with 1892. Several of them were published in the *American Mathematical Monthly*, volume X, 1903, page 87.

"The theory of congruences bases itself substantially upon a fundamental concept of mathematics, which is already the foundation of Poinsot's method, the concept of group."[1] "The group concept was employed in the preceding century (about 1770) simultaneously by Lagrange and Vandemonde, and since this time it occupies a prominent place in the theory of algebraic equations. In regard to this it is only necessary to refer to the name of Galois. Hence group theory has been regarded as a supplement of algebra. This, however, is incorrect, for the group concept extends far beyond this into almost all parts of mathematics."[2]

"The mathematics of the twenty-first century may be very different from our own; perhaps the schoolboy will begin algebra with the theory of substitution groups, as he might now but for inherited habits."[3] "A large part of the theory of numbers is

[1] Bachmann, Die Elemente der Zahlentheorie, vol. 1, 1892, Preface.
[2] Klein, Einleitung in die hoehere Geometrie I,I,., 1893, p. 3.
[3] Newcomb, Bulletin of the American Mathematical Society, vol. 3, 1893, p. 107.

only the theory of abelian groups."[4] "The concepts of group and invariant take each day a more preponderant place in mathematics and tend to dominate this entire science."[5] "Although we cannot give here a complete exposition of the fundamental results of Sophus Lie in the theory of continuous transformation groups, yet it is indispensable that we make some general remarks on the notion of the continuous groups which play such an important rôle in the science of our epoch."[6]

"Galois showed that to each algebraic equation there corresponds a group of substitutions in which the essential characteristics of the equation are reflected. In algebra the theory of groups has been studied at an early date, especially by Cauchy who introduced certain elements of classification. The study of Galois in the theory of equations exhibited the importance of the notion of invariant subgroup of a given group, and led him to divide the groups into simple and composite, a fundamental distinction which really extends far beyond the domain of algebra to the concept of groups of operations in the most comprehensive accepted meaning of this term."[7] "The whole subject of geometry may be regarded as a theory of continuous groups which define all possible collineations and motions."[8] "The theory of groups, which is making itself felt in nearly every part of higher mathematics, occupies the foremost place among the auxiliary theories which are employed in the most recent function theory."[9]

"There are two things which have become especially important for the latest developments of algebra; that is, on the one hand the ever more dominating theory of groups whose systematizing and clarifying influence can be felt everywhere, and then the deep penetration of number theory."[10] "In fine, the principal foundation of Euclid's demonstrations is really the existence of the group and its properties. Unquestionably he appeals to other axioms which it is more difficult to refer to the notion of group. An axiom of this kind is that which some geometers employ when they define a straight line as the shortest distance between two points. But it is precisely such axioms that Euclid enunciates. The others, which are more directly associated with the idea of displacement and with the idea of groups are the very ones

[4]Frobenius, Berliner Sitzungsberichte, 1893, p. 627.
[5]Lie, Centenaire de l'Ecole Normale, 1895, p. 485.
[6]Picard, Traité d'analyse, vol. 3, 1896, p. 492.
[7]Picard, Oeuvres mathématiques de Galois, 1897, Introduction.
[8]Russell, Foundations of geometry, 1897, p. 47.
[9]Fricke und Klein, Automorphe Functionen, vol. 1, 1897, p. 1.
[10]Weber, Lehrbuch der Algebra, vol. 1, 1898, Preface.

which he implicitly admits and which he does not even deem necessary to enunciate. This is tantamount to saying that the former are the fruit of later experience, that the others were first assimilated by us and that consequently the notion of group existed prior to all others." [11]

"The most important of all these viewpoints is furnished by the theory of groups, which is really a creation of our century and has shown its dominating influence in nearly all parts of mathematics; not only in the recent theories but also far towards the foundation of the subject, so that this theory can no longer he omitted in the elementary text-books." [12] "I should reproach myself for forgetting, even in so rapid a résumé, the applications which Lie has made of his theory of groups to the non-Euclidean geometry and to the profound study of the axioms which lie at the basis of our geometric knowledge." [13] "I desire to offer to the young students of the Italian universities a book which will introduce them to the study of one of the most important theories (groups) of modern mathematics." [14]

"It might be said of the most important parts of recent geometry that one conception dominates everywhere; that is, the conception of group." [15] "A department of mathematics that is universally acknowledged to be of fundamental importance is the theory of groups." [16] "The notion of transformation and of group acquires in the mathematical sciences, in analysis as well as in geometry, a more and more prominent place." [17] "In résumé we may thus say that the group concept, hardly noticeable at the beginning of the century, has at its close become one of the fundamental and most fruitful notions in the whole range of our science." [18]

"The important place which the theory of groups has taken in modern mathematics, principally through the works of Lie, is known. Its applications extend to higher arithmetic, algebra, analysis, geometry, and mechanics." [19] "The comprehensive meaning of the group concept, much more extensive than its earliest applications, appeared first in the works of C. Jordan. Starting from these the works of F. Klein and S. Lie made this concept a special object of investigation and brought it into the

[11] Poincaré, The Monist, vol. 9, 1898, p. 34.
[12] Pund, Algebra mit Einschluss der elementaren Zahlentheorie, 1899, Preface.
[13] Darboux, Comptes Rendus, vol. 128, 1899, 528.
[14] Bianchi, Lezioni sulla teoria dei gruppi di sostituzioni, 1900, Preface.
[15] Maschke, American Mathematical Monthly, vol. 9, 1902, p. 214.
[16] Major MacMahon, Nature, vol. 65, 1902, p. 448.
[17] Richard, Sur la philosophie des mathématiques, 1903, p. 229.
[18] Pierpont, Bulletin of the American Mathematical Society, vol. 11, 1904, p. 144.
[19] Conturat, Les principes des mathématiques, 1905, p. 329.

center of mathematical research." [20] "Sets, systems and groups, these three words are the technical names for conceptions which are to be met with in all branches of mathematics." [21] The fundamental rôle which the notion of group plays in mathematics is known. It furnishes a guiding principle which cannot be too clearly exhibited and which ought to inspire the teachers more and more, but we do not yet possess an exposition which confines itself to the most elementary applications." [22]

"Among the words which have exercised the most desirable influence are those of group and invariant. They have enabled us to see the real essence of many mathematical thoughts and have shown us that the ancient mathematicians employed groups in many cases without knowing it, and how they found themselves all at once together without knowing why, when they had considered themelves far apart." [23]

"The new foundation (of elementary geometry) has been laid in the nineteenth century by the works of leading mathematicians. It consists of the recognition that elementary geometry is equivalent to the investigation of the group of movements. Such a view is in accord with the characteristic tendency of modern natural scientists to replace static investigations of the phenomena by dynamic; or, to speak in more general terms, the thought of development penetrates more and more our observations." [24]

"Galois directed attention to the use of discontinuous groups in algebra. At a later date this concept was employed in number theory by Dedekind and others, and in the theory of functions by Klein, Poincaré, Picard and others. The theory of the solution of algebraic equations is principally based on the consideration of certain groups of substitutions or permutations of the roots." [25]

It is frequently impossible to form an accurate estimate of the value of a quotation without a study of the thoughts leading up to it. To facilitate such a study we have given the reference in each case. It is of interest to note that 8 of these quotations are from French writers, 7 are from German, 4 from American, 2 from English, 2 from Italian, while 1 is from a Norwegian and 1 from a Swiss. The many points of view represented in these quotations seem especially worth noting.

[20] Fano, Encyklopaedie der Mathematischen Wissenschaften, vol. 3, 1908, p. 293.
[21] Bôcher, Introduction to higher algebra, 1907, p. 80.
[22] Fehr. L'Enseignement Mathématique, vol. 9, 1907, p. 192.
[23] Poincaré, Bulletin des Sciences mathématiques, vol. 32, 1908, p. 175.
[24] Borel, Die Elemente der Mathematik, vol. 2, 1909, Preface.
[25] Mueller, Fuhrer durch die mathematische Literatur, 1909, p. 64.

THE TRAINING OF TEACHERS OF MATHEMATICS IN THE SECONDARY SCHOOLS OF THE UNITED STATES.*

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While greater attention has been given in the past to the training of elementary teachers than to secondary, yet it was comparatively early in the history of education that attention was given to the latter. Mulcaster was perhaps the first to suggest a college for teachers. A few years later, in 1619, Ratke founded a school for the training of teachers, which was soon after discontinued. In 1694 the first university pedagogical seminary was founded at Jena, where students were instructed how to teach mathematics and science in the secondary schools. In 1707 Francke provided for practice teaching in the secondary schools at Halle under the supervision of experienced teachers. In 1787 systematic training of teachers for secondary schools was inaugurated by Prussia, and from that time to the present courses in the history and theory of education have been given in most of the German universities.

In the United States the first institution to show an active interest in educational theory was the New York University, where in 1832 a chair of philosophy of education was established. Brown University organized a department of pedagogy in 1850, which was soon discontinued. From 1855 to 1870 not a college or university offered any course in education, aside from that given in normal departments for elementary teachers. By 1892 at least twenty universities were offering courses in education, chief among these being Iowa, Michigan, Wisconsin, Indiana, Cornell, New York, Minnesota, Nebraska, California, Stanford, Harvard, Clark, Illinois, and Chicago. According to the Commissioner of Education, 230 universities and colleges in 1904 reported teachers training courses, twenty-five of these institutions having departments of education. Of these 230 institutions the majority were undoubtedly training teachers for the elementary schools.

The tendency in the historical development has been to emphasize the importance of the theory and history of education.

*Read before the Mathematics Section of the California Teachers' Association, December, 1906. Revised to date by reference to the 1909-1910 university courses of instruction. References to historical data: Atkinson, F. W., "The Professional Preparation of Secondary Teachers in the United States," Leipzig, 1893; Luckey, G. W. A., "The Professional Training of Secondary Teachers in the United States," New York, 1903.

Within a comparatively few years the universities have begun to offer courses in educational administration, educational psychology, elementary education, and secondary education. In some of the institutions departments have been organized with titles corresponding to the above. And finally a few of the leading colleges and universities are offering courses in the teaching of the secondary school subjects. What has been done in the past to train in any special way the teacher of secondary mathematics? We may answer, almost nothing. The Germans alone seem to have recognized comparatively early that the teacher in the secondary school needed training in method and in practice.

In the United States the training of teachers for special work in mathematics has, until recently, been neglected by the universities. It was left for a few of the higher grade normal schools first to attempt this special preparation. The state normal schools of Wisconsin offered, in 1867, an advanced course of one year, in which among many other things the student learned geometry, trigonometry, and surveying; and it appears that the prospective teacher taught these subjects in the model school. The aim of this year's work, however, was to prepare students to teach, not in the high school, but in the higher grades of the elementary school. In 1892 the State Normal College at Albany, New York, was offering instruction in the methods of teaching algebra and geometry, plane and solid. In the same year (1892) the New York College for the Training of Teachers (now Teachers College of Columbia University) gave a course in the methods of teaching geometry. By 1895 the Michigan State Normal College at Ypsilanti offered, as electives, methods in algebra and geometry.

Within the last few years the departments of education in some of our leading universities have offered courses in the teaching of secondary mathematics, the leaders in this movement being Columbia University and the University of Chicago. Teachers College of Columbia University and the School of Education of the University of Chicago prepare teachers of secondary mathematics, and in their graduate schools train specialists qualified in turn to teach in institutions where teachers are prepared for elementary and secondary work. In addition to these two institutions, the following universities have organized their departments of education into Teachers Colleges or Schools

of Education: Cincinnati, Colorado, Howard (Washington, D. C.), Illinois, Indiana, Louisiana, Miami (Ohio), Minnesota, Missouri, Nebraska, New York, Ohio State, Ohio, Syracuse, Tulane (La.), and Wisconsin. With the exception of Illinois and Ohio University, all of these offer courses in the teaching of secondary mathematics. The following additional colleges and universities offer similar courses: University of Alabama, Baker University (Kansas), Bucknell University (Pa.), Colgate University (N. Y.), Cornell University, Earlham College (Ind.), State University of Iowa, University of Kansas, Knox College (Ill.), Marietta College (Ohio), University of Michigan, Milwaukee-Downer College, University of Montana, Mt. Holyoke College (Mass.), University of Oregon, University of Pennsylvania, Rochester University, Spokane University (Wash.), University of Texas, State College of Washington, and the University of Washington. Yale offers a course in the teaching of geometry. Yankton College (S. D.), Northwestern University (Ill.), and Heidelberg University (Ohio) emphasize the present teaching of secondary mathematics in their courses in the history of mathematics. Some of the larger normal schools also offer courses in the teaching of secondary mathematics and a number of the universities provide such instruction in their summer courses. A few of the universities and colleges not already mentioned offer courses which especially emphasize the methodology of the secondary school subjects, but these courses come under the general name of secondary education, and are given by professors, we judge, not generally familiar with either the science or pedagogy of secondary mathematics. In this connection we mention Carleton College (Minn.), University of Denver, Lawrence University (Wis.), University of Maine, and the University of Utah. It is probable that some of the other universities treat the methodology of secondary mathematics, but their catalogs make no mention of the fact.

There has been a remarkable stimulus given to the training of teachers of mathematics in the universities and colleges within the last three years. Three years ago the writer found from their catalogs that but ten out of thirty of our leading universities were offering courses in the teaching of mathematics. Today eighteen of that thirty are providing this instruction, while there are in all thirty-eight universities and colleges giving special attention to such work.

The following institutions that provide special courses in the teaching of mathematics require practice teaching: Chicago, Columbia, Colorado University, Indiana, Iowa, Kansas, Nebraska, Ohio State, Oregon, University of Washington, and Wisconsin.

The fact that the universities are beginning to offer courses in mathematical education indicates a demand that the teachers of mathematics be better fitted for their work, and this demand is not coming merely from the universities, but from the secondary schools as well. There seems to be a general recognition that we are on the eve of a renaissance in the teaching of secondary mathematics.

The teacher of secondary mathematics needs in the first place to be prepared in advanced mathematics. Not only should he have studied at least through the calculus, but he should be an able mathematician. A knowledge of the theory of functions, or better modern group theory, would serve to unify his conception of mathematics as a whole. But while we may not yet expect to have the great majority of our teachers of secondary mathematics familiar with the frontier of recent mathematical development, one result should be brought about, and that is that teachers should have some thorough knowledge of the foundations of the subjects they are to teach. The teacher of geometry who is not familiar with non-euclidian geometry, and absolute geometry in general, sees only one side of geometric logic and loses much thereby. A university course in the logic of mathematics could provide at least a part of this study of the foundations of mathematics. For thirteen years or more the University of California has offered courses in the logic of mathematics and in absolute geometry. Of the other universities of the United States, but a few are offering similar courses, namely: Clark, Columbia, Ohio State, Nebraska, Stanford, New York, and Western Reserve (Ohio). Colorado College emphasizes the logic of mathematics in the history of mathematics. Among other institutions that have offered such courses in the past are Cornell, Tennessee, Indiana, and Missouri. By virtue of his knowledge of advanced mathematics and of the logical foundations of elementary mathematics, the teacher is well equipped to interpret the subject-matter of secondary mathematics.

A second requirement should be demanded of the teacher of

mathematics in the secondary schools, namely, that he should be familiar with the history of mathematics. To this should be added a knowledge of the history of the teaching of mathematics, although as yet very little has been written in this particular field. In teaching, there must be breadth, there must be depth, and, not least, there must be perspective. And this last is what the history of mathematics and of its teaching gives to the teacher. A knowledge of the development of the subject-matter of elementary mathematics in succeeding ages, the relation of this development to the lives of the people in the various epochs, and the relation between the development of mathematics and of science form part of this fund of information. Some of the present problems of teaching secondary mathematics have a relation to the history of mathematics. A knowledge of the sequence of the development of the various branches and of the subject-matter of the individual subjects themselves should give a perspective whereby the teacher of to-day may act with clearer insight. We are reminded in passing that for ages the sequence of the subject-matter of arithmetic remained practically the same. The old plan of exhausting one topic before taking up the next has been abandoned. But in our secondary mathematics we are following, in the main, the traditional sequence of subject-matter.* Are we on the verge of breaking with tradition and changing the sequence of subjects and of subject-matter in order the better to meet present conditions? Certainly there are indications of such tendencies.

The value of the history of mathematics to the teacher is becoming recognized, but comparatively few of our prominent universities are offering such a course. The opportunities offered at Columbia University for research work in the history of mathematics excel those offered elsewhere in the United States, if not in Europe. Courses in the history of mathematics are also given at the present time at Brigham Young College (Utah), Brown, Carleton College (Minn.), Chicago, Clark, Colorado College, Colorado University, University of Denver, Indiana, Knox College (Ill.), Michigan, Missouri, Montana, Mt. Holyoke College (Mass.), Oberlin (Ohio), Ohio State, Olivet College (Mich.), Oregon, Pennsylvania College for Women, Rochester (N. Y.), Spokane (Wash.), Utah, University of Washington, Wisconsin, Yankton College (S.D.), Beloit College

*See the writer's "A History of the Teaching of Elementary Geometry--with Reference to Present-day Problems," Chap. VII, Columbia University contributions.

(Wis.), Boston University, and Heidelberg University (Ohio). The following especially emphasize the history of mathematics in their courses on the teaching of mathematics: Bucknell University (Pa.), Cincinnati, Iowa, Kansas, Marietta College (Ohio), Miami University (Ohio), Northwestern University (Ill.), and Ottawa University (Kansas).

It is not sufficient that the teacher of secondary mathematics be a capable mathematician, that he be informed on the foundations of his chosen subjects, and that he have a knowledge of the history of mathematics. He must also be master of the pedagogy of his particular field, and furthermore must have the breadth that comes from an acquaintance with general educational problems. Too often secondary teachers are satisfied, nay think it is their duty, to confine their teaching to the theory of the subjects that they teach. Let it be understood that the teacher of secondary mathematics does not cheapen his work by showing to some extent its significant applications. The teacher should have the same willingness to coöperate with the other departments and should realize that there are common ends that concern the school as a whole. There is the same need of an appreciation of general educational problems for the secondary teacher as for the primary.

We have already given a fair idea of what is being done to-day to train our teachers of secondary mathematics. In this connection we must remember that the majority of those teaching mathematics in our high schools are prepared merely on the side of subject-matter, although it is safe to say that in some of our smaller high schools algebra and geometry are taught by those who are not familiar with the calculus.

Where the control of courses of study and the appointment of teachers are left with the local school boards, it is hard to formulate any set standards. By centralized control of secondary schools, it has been possible for Germany and France to maintain a high standard in selecting teachers for their institutions. In Prussia before a teacher is eligible for a position in a secondary school he must comply with four requirements. First, he must have studied three years at a German university. Second, he must pass a state examination, including general education and the special subjects that he intends to teach. Third, he must attend one year at a gymnasial seminar where he receives theoretical and practical training, the latter including observation

and practice teaching. Lastly, the candidate must undergo a trial year.

In France not so many conditions are required, but all prospective teachers in the lycées must pass rigid state examinations. A series of three examinations are open for the candidates. Those who pass the highest of these are permitted to be professors and heads of departments in the lycées. Those who expect to teach in the elementary classes of the lycées must have passed at least the second of the state examinations. Many candidates for the higher positions seek admission to the three years' course of the École Normale Supérieure in Paris, where admission is by competitive examination and the applicants pledge themselves to teach ten years. In the United States we cannot adopt either the French or the German standards, but we can work toward the same end, that of having teachers who are competent to fill the positions they are seeking.

What then should we formulate as the proper university training for the prospective teacher of secondary mathematics in the United States? The present tendency gives us the key to an answer. The candidate for a certificate to teach mathematics in our secondary schools should be required to take (1) advanced courses in mathematics; one of these should be on the foundations of mathematics; (2) history of mathematics and its bearing on teaching; (3) courses in general education and secondary education in particular; (4) a course in the teaching of secondary mathematics, this given by one familiar with advanced mathematics, the history of mathematics, and the general field of education; (5) observation and practice teaching in connection with this university training, under the supervision of a specialist in mathematical education. Lastly we may hope that candidates be not admitted as full secondary teachers until they have shown after a year's trial that they are specially fitted for the work.

We restate a summary of catalog data for 1909-10 by grouping the universities into three classes.

Column (1) gives the number of institutions that have Colleges of Education; column (2), courses in the teaching of secondary mathematics; column (3), practice teaching in mathematics; column (4), courses in the history of mathematics; and column (5), courses in the logical foundations of mathematics.

	(1)	(2)	(3)	(4)	(5)
Members Association of American Universities	8	13	10	7	6
Members Association of State Universities	12	19	14	10	3
Other colleges and universities	4	16	2	16	2
Totals (omitting duplicates)	18	38	19	29	8

GEOMETRY IN THE HIGH SCHOOL.

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The data for this paper are obtained from the latest official publications* of the education departments of those states which publish high school courses or syllabi.

The average time which a pupil taking a four years' course in a high school in this country devotes to mathematics is 3.69 years. If he seeks to avoid mathematics, but still completes a four year high school course, the average minimum time for his mathematics is 3⅓ years. If he is in Boston where the elective system is in full operation he may take his choice between a year of algebra or a year of geometry.

*Course of study for county high schools of Alabama, 1908. Course of study for Arizona schools, September, 1908. A four years' high school course in mathematics, Arkansas, 1909. University of California *Bulletin*, May, 1909. Biennial report of the Superintendent of Public Instruction in the state of Florida, June, 1908. Courses of study and teachers' manual for the public schools of Idaho, 1908. Uniform course of study for the commissioned and certified high schools of Indiana, 1909-10. Course of study for the high schools of Kansas, 1908. The county high school courses of study, Kentucky, 1908. State course of study for high schools of Louisiana, 1909-13. Minimum requirements for approval with suggested courses of study for free high schools and academies, Maine, 1909. Maryland public school system by-laws and course of study, 1908. Boston Public Schools, school documents numbers 3, 4, 7, 15, and others, 1909. Course of study for the high schools of Michigan, 1905. Nebraska high school manual, 1908. The work of the school room. Secondary schools New Hampshire, 1908. Syllabus for secondary schools, New York, 1905. Syllabus for high schools, New York City, 1906. Hand book for high school teachers containing courses of study prescribed for the public high schools of North Carolina, 1907. Manual of the high school board of North Dakota, 1909. Course of study for the public schools for the state of Oklahoma, 1909. State manual of the course of study for the public schools of Oregon, 1908. Manual for the borough and township high schools of Pennsylvania, 1909. Synopsis of course of study, South Carolina, 1908. Course of study for the high schools of South Dakota with syllabi of subjects, 1908. Utah school report, 1906. High school circular, Utah, 1908. Minimum courses of study, secondary schools, Vermont, 1907. Standard of requirements for high schools, Virginia, 1906. Outline course of study for high schools, Washington, 1907. The high school curricula in the United States, Washington, 1909. A manual containing courses of study for the high schools of West Virginia, 1909. Manual of the free high schools of Wisconsin, 1906. College entrance examination board reports, 1909.

In a previous paper (SCHOOL SCIENCE AND MATHEMATICS, February, 1910), I have shown that 1.8 years or about half of the above time is given to algebra. Of the remainder, 1.46 years are given to geometry; or when the student seeks to avoid geometry as much as possible he may reduce this time to 1.23 years, the average minimum period devoted to geometry. This last figure includes in some cases plane geometry and in some cases plane and solid geometry, and also makes allowance for the boy in Boston who may take no geometry at all.

The data from which these figures are made up are from only thirty states, practically all that have syllabi upon the subject, yet they present so great a uniformity in the length of time devoted to geometry that it seems doubtful if more complete returns would change perceptibly the averages, especially as the states which publish courses include such geographical extremes as Maine and California, Michigan and Florida. Twelve states out of the thirty do not make solid geometry a requirement. Louisiana, North Carolina, and Virginia devote a little less than one year to plane geometry (four hours a week for one year). The fact that Euclid's Elements forms a necessary basis for the work has held the schools together in geometry much more closely than in algebra.

Several of the states recommend the introduction of geometry in elementary schools. For example, in the Kansas syllabus we find the following: "As long ago as 1892, the Committee of Ten, influenced by the mathematical curriculum of the schools of continental Europe, recommended that systematic instruction in concrete (intuitional, non-demonstrative) geometry be given in the grammar grades." The State Teachers' Association of Wisconsin, as reported in the syllabus of that state, gives as a minimum requirement one hundred and twenty-eight propositions in plane geometry and sixty propositions in solid geometry. Louisiana says: "Omit the proof of the π theorem, and incommensurable cases in limits." Indiana recommends the omission of the less comprehensible theorems like "To construct a square having a given ratio to a given square," "To construct a polygon similar to one polygon and equivalent to another," "To divide a line in extreme and mean ratio," "To construct a regular decagon," and the computation of the side a regular polygon in terms of the radius.

Some of the states prescribe the number of original exercises. New Hampshire requires original exercises sufficient fully to il-

lustrate the propositions and give the pupil adequate practice in independent geometrical thinking. In that state 43% of the schools complete more than 400 originals; 60%, more than 300 originals in plane geometry. And 82% of the schools complete more than 100 originals in solid geometry. One syllabus states that the pupils should take from 200 to 400 original exercises, of which 150 should be written out in full, and corrected by the teacher. Other states prescribe 100 exercises per book.

In the New York city high schools the work of the first half year consists of Books I and II omitting measurement of angles, with 75 exercises per book. Louisiana requires Books I and II and the originals in the text. Michigan takes 70 theorems and 140 exercises, including those requiring original proof and many illustrative arithmetical and geometrical examples. In the second half-year Michigan covers 75 to 90 theorems and twice as many exercises.

	Time for Mathematics Years	Minimum Time for Mathematics Years	Time for Geometry Years	Minimum Time for Geometry Years
Alabama	4	4	1.5	1
Arizona	4	3	1.5	1
Arkansas	4	4	1.5	1
California	3.5	3.5	1.5	1.5
Florida	4	4	1	1
Idaho	3.5	3.5	1.5	1.5
Indiana	3.5	3.5	1.5	1.5
Kansas	3	3	1.5	1
Kentucky	4	4	1.5	1.5
Louisiana	3.4	3.4	1.2	.8
Maine	3.2	3.2	1.6	1.6
Maryland	4	4	1.5	1.5
Massachusetts	4	1	2	0
Michigan	3	3	1.5	1.5
Nebraska	3	3	1.5	1.5
New Hampshire	4	3.5	1.5	1.5
New York	4	4	1.5	1.5
North Carolina	4	4	1.1	1.1
North Dakota	4	2	1.5	1
Oklahoma	4.5	4	1.5	1.5
Oregon	3.5	3	1.5	1.5
Pennsylvania	4	4	1.5	1.5
South Carolina	4	4	1	1
South Dakota	3	2	1.5	1
Utah	3.6	3.6	1.5	1.5
Vermont	3.6	2.6	1.5	1
Virginia	3.6	3.6	1.3	1.3
Washington	4	2	1.5	1
West Virginia	3	—	1.5	1.5
Wisconsin	4	2	1.5	1
Average	3.69	3.26	1.46	1.23

One syllabus gives as the aim of the course in geometry the acquiring of familiarity with the common geometrical figures and the theorems relating to them; ability to construct such figures accurately with rule and compasses; appreciation of deductive reasoning and resourcefulness in applying deductive processes to the solution of exercises of moderate difficulty. It gives nine steps to be taken in accomplishing this aim. All of the syllabi contain interesting and practical suggestions on the teaching of mathematics.

The appended table substantially explains itself. As a rule the time given to solid geometry is half that given to plane geometry although in Boston solid geometry takes a full year. Bookkeeping is not included under the time given to mathematics, but in some cases one-half year of advanced arithmetic is included. The table is made on the basis of a four years' course.

PRODUCTION OF PLATINUM IN THE UNITED STATES.

The decline in price of ingot platinum on the New York market from $38 per troy ounce on January 1, 1907, to $25 per ounce on December 31 of the same year, was accompanied by a notable decrease in production of fine platinum—from 1,439 ounces, valued at $45,189, in 1906, to 357 ounces, valued at $10,589, in 1907. Of the total output in the later year, 300 ounces came from Butte, Del Norte, Humboldt, Placer, Plumas, Trinity, and Sacramento counties, in California, and 57 ounces from Coos, Curry, and Josephine counties, in Oregon.

In an advance chapter from "Mineral Resources of the United States, Calendar Year 1907," on the production of platinum in 1907, David T. Day of the United States Geological Survey says:

"The decline in price in the United States increased the feeling of insecurity on the part of the platinum miners as to the value they would secure from their material and rendered the search for platinum less active."

The total value of platinum metals imported and entered for consumption in the United States in 1907 is given as $2,684,642—a decrease of $1,104,117 as compared with the value of the imports in 1906.

Continued interest is shown in the project for developing the platinum localities in the department of Cauca, Colombia, but development work has not yet reached the point of commercial production.

Contracts for practically the entire supply of platinum in Russia have been made for a number of years ahead, and fluctuations in prices have no significance in regard to the total annual output.—*United States Geological Survey.*

PRACTICAL TECHNICAL CHEMISTRY IN OUR SCHOOLS.[1]

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The usefulness of a machine depends upon the care and precision with which its parts are constructed and assembled. We may draw an analogy between the usefulness of a machine and the usefulness of a technicist and say, the usefulness of a man depends upon the care and effectiveness of his preparation. In the constructing and assembling of the various parts of a machine we have the great advantage that when a machine which will do a particular kind of work perfectly is once made, there is comparatively little difficulty in making more machines which will do the same kind of work equally well; but, for various reasons, the preparing of men for any particular work, presents many difficulties. Each man is truly the raw material which must be examined as to its qualities and made the subject of an extended research or investigation by the various instructors who, *in toto*, produce some sort of finished product—finished product so far as the school is concerned but as yet only concentrated raw material from the standpoint of the established technicist.

The advantage mentioned regarding the extreme ease of producing machines of exactly the same capability becomes in this latter instance a decided impossibility. The finished products from the standpoint of the school, can be at best only similar and in many instances it may be difficult to recognize even a similarity; and this because of the very uncertainty of the raw material, its widely different qualities, and the vastly different conditions of workmanship and of quality of workmanship existing in our schools. The raw material in our present question is the man; the workmanship the various branches of knowledge presented to him; and the quality of workmanship the manner of presenting these.

The branches of knowledge which should be presented to produce a man with the best qualifications for a chemical engineer have been fairly definitely agreed upon, but the exact manner of presenting these branches of knowledge is a question which has been considerably discussed—the end of which discussion probably none will venture to predict. It is, therefore, difficult to find any branch of knowledge, the presentation of which has not been more or less fully discussed and especially is this true of technical chemistry.

[1]Read before the chemical section of the Central Association Science and Mathematics Teachers in Chicago, Nov. 26, 1909.

Technical chemistry, as defined by Professor W. H. Walker of the Massachusetts Institute of Technology,[1] may be regarded as the performance of a chemical reaction or series of reactions on a scale sufficiently large and by a method sufficiently economical to enable the product to be sold at a profit. From this definition it is evident that a course in chemical technology to be at all complete must comprise two phases; a study of the purely chemical side and also a study of the methods used in technical works to carry out the chemical reactions. These must go hand in hand to be most comprehensive.

It is generally agreed that a broad training in physical sciences and mathematics is far superior to detailed training in a few subjects; and the great number and widely varied industries in technical chemistry make it out of the question to cover these in detail, no matter what time is available. And neither is it desirable to study these industries in too much detail since it is the rare exception for a student to know exactly what kind of work he is going into, and if he does know, no one can predict the particular problems of the innumerable possibilities in that industry which in the future will be presented to him for solution. The technical chemist or chemical engineer, as he is more properly called, in beginning his career dives into a continuous stream of problems—problems of two kinds. First, he must work out new processes, improve old ones, turn waste products into useful ones, etc. This is the pure chemistry in which he must apply all his chemical knowledge. He is truly a scientific research chemist. Having accomplished this he must solve the second problem to make his process a technical success. Special apparatus must be designed to handle the material and to produce the best possible product at the least possible cost. He is certainly an engineer. He should be prepared to cope with any problem of a chemical or engineering nature. He must, therefore, be given a broad foundation in school that he may be able to specialize in any branch of chemical technology when the time comes. It comes after he has entered the technical world.

The discussion of the particular studies, other than technical chemistry, which best provide a student with this broad foundation, has no place in this paper.[2] We are concerned here only with the course in chemical technology.

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[1] Electrochemical and Metallurgical Industry Vol. 3; p 27; 1905.

[2] For discussion of this subject see
W. A. Noyes, Science, 15, 382, 1902.
A. Lachman, Science, 15, 775, 1902.
J. B. F. Herreshoff, Science, 19, 561, 1904.
E. H. Miller, Chem. Eng., 1, 400, 1905.
W. H. Walker, Chem. Eng., 2, 1, 1905.

The opinion of the foremost technical chemists and teachers of the country is that a broad training is much better as a preparation for a technical chemist than specializing at its expense. If this opinion is the correct one, and doubtless it is, why should this not apply equally to the course in chemical technology which should be the cap of this preparation, and which besides giving the student a broad training in technical chemistry should teach him to think and to apply what he has learned in general, analytical, and physical chemistry, and in engineering? The broad training can be given by class room work—illustrated lectures, recitations, and written papers; by visits to as many chemical works as possible; and by lectures by practicing technical chemists. Laboratory work of the proper kind, putting the student on his own resources to work out simple practical problems, involving the search for appropriate data and the necessary mathematical calculations will teach the student to think. The course in chemical technology in colleges and technical schools could be profitably extended over a period of five semesters, two or even three hours a week; an arrangement which would not be impossible.

At the beginning of the second semester of the sophomore year the student has become sufficiently acquainted with chemistry to understand the ordinary reactions carried out in technical chemistry and to be able to follow the general technical operations. This semester, then, could be very profitably devoted to class room work in the study of general techno-chemical operations such as evaporation, precipitation, crystallization, lixiviation, levigation, calcination, fuels and heating, absorption of gases, refrigeration, etc., together with the study of the machinery used for these purposes.

At the beginning of the junior year the student will have had sufficient analytical work to enable him to follow intelligently the class room work in inorganic chemical technology. Similarly, he will have had sufficient organic chemistry to be able to comprehend the organic chemical technology during the second semester of the junior year. Finally, during the whole of the senior year the course will be one of chemical engineering, practical technochemical problems, and laboratory work. The laboratory work should be in the nature of research. The spirit of research must always be present if the course is to be most effective. The conditions governing the choice of suitable experiments may be concisely stated as follows.[3]

[3]W. H. Walker, transactions of the American Electrochemical Society—Vol. 9; p 23 1906.

The experiment must adapt itself to reproduction on the laboratory scale, and this scale should be chosen as large as possible in order that one can detect and solve problems which could not be detected with the small quantities used in ordinary laboratory experiments.

The raw materials used must not be expensive.

The experiment should admit of theoretical discussion and thus the results of the planned experiment be predicted as far as possible.

The experiment must admit of obtaining fairly concordant results when carried out by different students.

As far as possible the experiment should be given an economic setting and the cost of manufacture compared with the cost of other processes for obtaining the same product, and with market prices.

Suitable experiments are such as the preparation of pure sodium chloride or potassium chloride from an impure product, or the preparation of a pure salt from a natural mineral, or, if desired, the preparation of one of the numerous organic compounds. In carrying out any of these the student should be required to do his own thinking as far as possible, to determine what impurities are present, and to formulate his own method of procedure accordingly. He should refer to articles on the crude material and on the substance he is to make, solubility tables, and market price lists, in order that he may use the cheapest chemicals possible in his purification and add no more solvent than necessary, that the least possible heat may be required for evaporation. In short, he should be required to think out his complete process in advance in order that there may be no waste of time or energy or material while carrying it out. An idea of the cost of production should be obtained by measuring the gas used to carry out the whole process, or by keeping a record of the weight of water heated and evaporated and from this calculate the heat absorbed. Finally, a calculation of the total cost of production should be made and compared with the market price of the same material. In this, however, it must be kept in mind that the relative cost of production is nearly always greater on the small scale than on the large scale. The designing of a plant to carry out the manufacture of one of the products experimented with, based on the observed data, and for a definite output, is excellent practice. Every experiment, therefore, should be of an investigating techno-chemical

nature, during which and from the data of which the student will be required to apply the knowledge he has acquired in all his other courses. The simultaneous class room work should offer opportunity to discuss the investigation and calculations of each student; and numerical techno-chemical problems should be given which will allow of the application of the principles of physical chemistry and engineering questions. The application of mathematics to chemical problems has not received the attention it deserves. The time is not far distant when a man well trained in the mathematics of chemical engineering will have a big advantage in the techno-chemical field.

One of the important features of a course in chemical technology should be the realization of the magnitude of chemical operations as they are actually carried on in technical works. This can be but very imperfectly given in the class room, and the only effective method is to conduct a series of visits to manufacturing plants. These visits should be as frequent as possible and every student should be required to write a report of each visit.

The whole course is much simplified and intensified by the aid of a good and complete set of lantern slides giving sections and external views of the various apparatus used in technical works. The sections are of vastly greater importance, as these are necessary for the explanation of the various processes in the class room. If the external views of the machinery are available so much the better; but these are not as important as the sections.

In a secondary school course, chemical engineering is unquestionably impossible, but industrial chemistry to a limited extent may be readily introduced into the chemistry course with profit. This is especially true of the technical high school. Some college professors firmly hold that no attempt should be made in the secondary school to teach anything but the rudiments of the science; and that it jeopardizes the pupil's future study to attempt to give him anything in the way of the applications or latest developments. These the student will learn in his college course. True, but many of our high school pupils are unfortunate in that they never go to college. The secondary school teacher, therefore, should aim to solve two problems. He should give his pupils a sufficiently thorough foundation to satisfy the college entrance requirements, and he should at the same time aim to make the course sufficiently broad and show enough commercial

and daily life applications to make the course as interesting and useful as possible to those pupils who go no further. The interest for all pupils, moreover, is kept alive by showing them applications of what they are learning. Further, if in connection with the lessons on the different chemicals they are shown diagrams of the apparatus used in commercial manufacture and told a few facts which will teach them the wide application of the subject, what they learn will remain with them longer. It will also be of greater service to them and make them desirous of learning more For this purpose lantern slides giving sections and external views of technical apparatus are extremely convenient; and these, together with occasional visits to local manufacturing plants make a secondary school course much more interesting and instructive.

THE PURPOSE AND METHOD OF THE CHEMISTRY COURSE IN THE PUBLIC HIGH SCHOOL.[1]

By Frank B. Wade,

Shortridge High School, Indianapolis.

It is with some hesitation that I am presenting a paper on this subject before a body of teachers, most of whom are my seniors in age and in experience.

Each year brings to light so many new and better methods of teaching old truths that one is led to wonder how any written article on method will read one year from date.

Perhaps, however, by confining my attention largely to a general treatment of the method rather than its details, I may be able to be of service to those who are my juniors in the work. Let us then consider first the field of effort, analyze if possible the human material upon which we are to work, determine what is best for the majority of our pupils, and then try to find the best manner of teaching the scientific method of thought while considering the facts of chemistry.

If we look over the ground, we will probably find that the pupils who come to us for chemistry will fall rather naturally into one of three classes.

First, the rather small, but increasing number who are to go

[1]Read before the Chemical Education Section of the American Chemical Society, Boston, Dec. 28, 1909.

to college. This class perhaps constitutes a majority of influence and is thus worthy of due consideration.

Second, and still numerically small, is the class of those who hope to make their chemistry of service to them in their vocations. With the spread of industrial, as distinguished from technical, training, this class is likely to increase. Its influence, unless a much broader idea of training is adopted than is at present aimed at by the advocates of industrial training, will, I fear, fall far short of that which it might attain.

Third, and most numerous of all, is the class of those who take chemistry as a part of a good general education that they may be trained in a subject which is of much importance in this scientific age, but with no idea of pursuing it further, either in college, or as a vocation.

Having now classified our pupils, we may attempt to ascertain what will be best for the majority of them.

Considering first that class which plans to go to college, I think that we will agree that their course in chemistry should be laid out upon broad general lines. They should be taught the fundamental principles of the subject together with the leading facts and the most useful part of the theory. More than all else they should be trained in the scientific mode of thought. We should show them how to attack hard propositions systematically and successfully. As Dr. Thorndike puts it, "to foster those ideals of method and attainment which inspire and guide intellect and character, to teach the lessons of *work, accuracy, thoroughness, science, responsibility,* and *service.*"

This sort of training will be found to be the best preparation for college, regardless of college entrance requirements. There is not a college but what would rather accept a man with power to think chemically rather than one who has perfunctorily covered certain required portions of the subject of chemistry. Even Harvard, ultra conservative as she has sometimes been thought to be, will gladly welcome the man who can convince her authorities that he has this power, even though he may have failed to cover exactly the ground outlined in her entrance requirements. When we have succeeded in some measure in thus training a pupil to think, let us send him up to college advising him not to claim too much credit for the work he has done in chemistry in the secondary school, but to enter the beginning course in college prepared to make a high standing in it.

With seven to ten periods per week for one year in the chem-

istry course in any good school the boy who expects to go to college should acquire enough of the subject itself, while acquiring power to think, so that he should readily be able to pass the ordinary entrance requirements.

It would seem then that we need not trouble ourselves much about the boy who intends to go to college.

Next in order comes that class who hope to use their chemistry vocationally. I think that it will be easy to show that the sort of course I have indicated as best for the boys who go to college will also be best for those in the vocational class.

We cannot expect to make a practical chemist in a year. All we can do is to lay foundations. If we try to do otherwise, we shall be educating our pupils for the bottom.

Give them the broad general training and the power to think. They can acquire the technical side of the subject in a commercial laboratory but almost never can they get the breadth there. This breadth they must have if they are to go very far. They will constantly need it in practical work.

You remember the story of how one of our prominent industrial chemists succeeded through his knowledge of the whole field. The Standard Oil Co., it was said, had accumulated a vast amount of dirty, sludgy sulphuric acid from the refineries. They were enjoined from dumping it in the rivers, they were forbidden to dump it on the land, they could not give it away, they could not afford to store it or to purify it. They had an elephant on their hands. In this predicament they went to the chemist with the general training.

"What shall we do with it?" they said. "Sell it!" said he. "To whom?" said they.

"Why—to the phosphate fertilizer people," said he. "They will be glad it is so dirty." And they were. The check for $10,000 which he is said to have received is a sufficient commentary upon the industrial value of the broad training.

Now for our last and most numerous class—the numerical majority who take chemistry as part of a general course.

Could we do better for them than to give them also a broad training in the fundamentals of our science? It will give them understanding and appreciation of the spirit and methods of this scientific age. It will make for intelligent coöperation on their part with the few who get the further technical training in chemistry, in their efforts for public service, such as the enforcement of wise legislation in regard to pure food supplies. Such a

course will correct ignorant popular conceptions of the possibilities of science and will show the actual possibilities before it.

It will give training in accuracy of handling, accuracy of observation, of thought and of expression, and this will give power.

This power and these habits of thought and of action can, and will, be used in later life upon other and very different problems, perhaps unconsciously, but nevertheless surely.

It thus appears that that course which is best suited to all three of our classes is the broad general course in the fundamentals of the subject rather than any narrower course designed to give special training at the expense of breadth.

We may now consider briefly the second part of our subject and attempt to outline some of the more salient points of the method by which our purpose may be accomplished.

In the first place let us be sure to recognize our limitations, to appreciate how very little we can really accomplish upon the mass of habits of the individual in a single year, particularly where we have to handle large numbers and so can have but meagre opportunity to get in personal touch with the individual.

Let us remember how little of that which we got in our own high school course in chemistry really became our own, and how much we had to learn over again later on.

If we thus appreciate the limitations of our work, we will not try to accomplish impossibilities and will be far surer of making real progress in the training of the individual.

Let us consider the age and the stage of development of our pupils and try only to cover that ground which we find it possible to cover thoroughly, and if we are thereby forced to omit many things which it would be most desirable to teach, let us recall that they would merely serve to efface other and perhaps still more desirable things if we attempted them.

With such a general method of attack, it is obvious that we can make only a small beginning at teaching the subject of chemistry and that we will be forced to select a few only of the more essential elements of general inorganic chemistry and try to drive them home, while using them as a foundation for training the mind of the pupil in the scientific mode of thought.

Let us treat these few elements of the subject broadly and thoroughly.

Let the idea of homogeneity versus heterogeneity of substance be thoroughly impressed. Let our chemistry deal with the interaction of substances and the properties of substances rather than with atoms and molecules.

Let the language of experimental fact be constantly in our mouths, and yet when sufficient facts have accumulated to justify generalization, let us not be afraid to use a good theory and to advance it as the most practical and most useful thing one could have at that point, justifying its use on the ground that it serves as a working basis for more advance.

Let us treat the essential facts that concern combustion and all oxidation giving the broad view of oxidation and showing that not only oxygen but any chemically active element may be the oxidizer and that, in the broadest sense, the thing which we ordinarily call the fuel is as much the oxidizer as the oxidized.

Let us teach from the first that there is no real reason why any reaction should not become reversed under some new set of conditions and constantly call attention to such as are commonly seen to reverse themselves.

Let us search air and water, and the common things contained therein. We shall find ample opportunity in connection with them to teach the laws of gases and of solutions, of combining weights and atomic weights, and how formulae are found. When we have thus given concrete illustrations of these things, we will find our pupils making intelligent use of atomic weights, of formulae and equations.

Let us proceed steadily from the known to the unknown and constantly call up and review the known as opportunity offers.

Where an active mind among the pupils sees a lead into a new topic, use it to teach that new topic and use it at once if it really affords a natural transition even though your carefully prepared outline had reserved that new topic for future consideration You will likely teach it more effectively than ever before.

While the pupils are thus acquiring the main points of the course, let them be allowed, nay, required, to follow the work in each of two or three good elementary texts and see that such texts are provided in sufficient number that every pupil can get at one or more at any time. Have also a few copies of such college texts as Alexander Smith's "General Inorganic Chemistry" at hand and you will find the more ambitious among your pupils devouring them to their great advantage. Let the teacher himself give the historical setting of the work as it progresses and also show it in its inter-relations with the other sciences and in its applications to practical uses in daily life.

SOME PROBLEMS IN SECONDARY SCIENCE TEACHING.[1]

A DISCUSSION INTRODUCED BY W. M. SMALLWOOD, AS PRESIDENT OF THE NEW YORK STATE SCIENCE TEACHERS ASSOCIATION.

Syracuse University, 1909.

From college president down to layman the warning is being sounded. When President Hadley of classic Yale said, "The tendency to early specialization has resulted in making college boys *narrowly* expert, to the exclusion of leading ideas and principles needed at every stage of their career," he little dreamed that identical views would soon be advocated in a notable commencement address before one of the professional engineering schools of the middle West. The sum of this agitation amounts to a challenge.

No one expects to return to the old classic plan of training, not even the most conservative; but the conservatives as well as many others are demanding that the various modern branches, the sciences in particular, shall be so studied as to do for the student what it is claimed the time honored subjects have done. Is there produced breadth of vision and depth of thinking, together with the discipline that comes from frequent repetition? This is the challenge that we must meet, and even that eminent chemist, President Remsen, is suspicious that the challengers are in the right.

A short historical excursion into the conditions in this state may serve to illustrate the great change that has taken place in the extent and methodology of the sciences. The report of the Regents concerning Columbia University in 1857, whose science work was more extensive than that of any other college in the state, runs as follows: "With the professor of physics, chemistry, etc., the class pursued the study of mechanics, pneumatics, hydrodynamics, heat and its application, including steam engine; electricity and magnetism, with their application to telegraphic and other uses; light, according to the undulatory theory; and the principles of construction applied to civil engineering and to architecture; the latter being studied æsthetically more than practically.

They were taught chiefly by demonstrations of the facts, apparatus, experiments, etc., models and diagrams being largely

[1] Read at the annual meeting of the New York State Science Teachers' Association at Syracuse in December, 1909.

employed, by oral instruction and explanation, upon which notes fully written and recitations were required.

Ten years later in the report from Union College is found what appears to be perhaps the earliest announcement of regular laboratory work in the colleges of this state, in these words: "In the undergraduate department, chemistry is taught by daily lectures and recitations during the first and second junior terms. Undergraduates are also permitted to attend the daily two-hour course of experimental chemistry at the laboratory, for which there is an extra charge of $12.00 per term for instruction."

Thus it is seen that from thirty to fifty years after the epoch-making discoveries of the early century in chemistry and physics, these two sciences were still unappreciated, and that geology and biology were unrecognized as suitable subjects for college students. But the tremendous stimulus imparted by the application of even the few known scientific principles to economic and practical affairs furnished such a powerful dynamic force that their quick recognition and adoption as subjects of educational value followed. So sudden has been this transition that a short fifty years has elapsed when we find the laboratory method universal, and in many instances, even in the secondary schools, regarded as the most important and only legitimate avenue to new information.

With the recognition of an unusual amount of educational unrest, and with a sudden popularization of the laboratory method in secondary schools, it is but natural that many old problems thought to be settled, appearing in a new form demand re-examination and some readjustment. The point is illustrated by the reply of the representative of the Japanese nation, who, when asked how it was that his people had become so proficient in so short a time, said that it was "all in three words—adopt, adapt, adept." The critics of the sciences have ceased to consider the first and second propositions, and are now debating the success of the sciences in producing intellectual *adeptness*.

In the discussion of the following problems I am under obligations to a considerable number of prominent secondary school science teachers distributed from Colorado to Maine, as well as to some college professors, who have kindly expressed their views in reference to each of the following questions:

1. **Should the influence of the colleges on Secondary science be increased or lessened?**
2. **What should be the main purposes of Secondary science?**

3. What are the present leading tendencies in Secondary scientific education?

4. Should there be more or less laboratory work?

5. Should the High School pupil know in a general way something about the principles to be studied before doing his laboratory work; or first do the laboratory experiment, then deduce the principles?

1. *The Relation of the College to the High School.*

In the recent report of President Prichett of the Carnegie Foundation it is shown that from 58% to 75% of the entering freshman class in some of the leading universities are conditioned in one or more of the entrance requirements. Of course the newspapers herald these as delinquent colleges. A little inquiry elicits the fact that what is true of the colleges named in the Carnegie report is a general condition. If these colleges are delinquent, they at least are not lonesome. However, delinquency is not the only explanation. In direct reply to my question, "Should the influence of the colleges on secondary science be increased or lessened?" 10% advocated a coöperative system between the two, whereby the college should begin where the high school leaves off; 7% advocated that the influence of the college should be increased; while over 80% were certain that the college influence should be lessened.

These facts, and those of President Prichett's report, suggest that the high schools have their own distinct problem, and that the old ideal of preparing less than 10% of the pupils for college is not to be their exclusive purpose in the future. When the high schools are going about their business in such independence that so large a percentage of those entering for college are unable to meet the varied entrance requirements, one must infer that they have decided to strike out along new lines for the training of the 90% of their pupils.

In several of the colleges of this state the science courses begin without any recognition of previous work, because of the feeling that the point of view, scope, and method are so entirely different in the high school that no attention need be given to this earlier work. This does not mean that the high school science work is not valuable, nor that it should on this account be changed, but is rather an indication of the beginning of the adjustment that is gradually taking place between the high school and college. One of the replies succinctly states the situation as follows: "If the question means should the colleges influence secondary schools as to what they shall teach and how

they shall teach, NO. If it means shall the colleges stimulate by pointing out new things and new ideas, YES."

2. *What should be the main purposes of Secondary Science?*

A few of the replies directly quoted will best show how this question was answered. "That eyes may see more clearly, that mind interpret things seen more accurately, and that pupils learn to tell the truth about things seen. This is its educational purpose. The practical results so-called are secondary."

"The main purpose should be to train the pupils to be able to think logically and exactly; the laboratory work should give the pupil the ability to express his purposes in action and draw conclusions from the results."

The main purpose of secondary science should be to give the pupil a fund of information about the phenomena of nature, together with such knowledge of the laws concerned therewith as to enable him to explain them intelligently. I would emphasize the informational idea particularly in natural history studies rather than the theoretical one. In physics and chemistry, where the pupils are more mature, the theories of those sciences may be more strongly emphasized; but the tendency toward more of the general informational treatment has become notably more marked in those studies also, particularly in secondary schools."

These replies just quoted are from high school teachers. The following is by a normal school man: "To secure for the pupil the ability to adjust himself sanely to the essential realities of life, individual and social; 'adaptation without the loss of adaptability.'"

The following three are by well-known college professors:

"I should say two purposes equally important: (1) organized and exact information about our natural surroundings, and (2) training in exact observation and clear method of thinking."

"In all science teaching there are two main objects: discipline and information. Neither of these can be profitably pursued to the exclusion of the other, but I think that discipline should form the chief aim of the secondary schools."

"In my estimation science in the secondary schools must find its justification in the influence that it exerts upon the student in developing alertness to the presence and meaning of things in his environment, in developing rational attitude of mind towards natural phenomena and materials, both as to their genesis and possible application to human affairs, and in developing initiative and originality in dealing with these things."

In none of the replies is there any mention of so conducting the work as to articulate it with college courses, although 10% in replying to one of the other questions expressed such a preference. One sees in all the replies the dominant note of discipline as the foremost purpose. That so much sanity is general is a refutation of the sensational writers and a cause of congratulation to the many who recognize that the boy of to-day needs the same essential kind of training that the boy of 100 years ago needed to enable him to become a well-trained and successful man. It should also be kept in mind that science has not thus far discovered that the boy of to-day possesses any additional powers, or that his mental development passes through any different courses from those of olden times. Furthermore, it is readily apparent that many of the practical teachers believe that the sciences are important subjects in producing this much-to-be-desired discipline.

The recent irrigation plans of the English engineers in Egypt are found to follow the cruder but effective general plans of Joseph of Biblical times. The plans of the engineers of to-day are a great improvement over those of their eminent predecessor, yet there is nothing essentially new. The purpose of irrigation is to distribute water to the growing crops. Modern engineering does this more perfectly and with less waste. The challenge previously mentioned raises the question whether these modern subjects are as effective as the old time ones. This point cannot be absolutely settled for several years. The champions of the older subjects and methods can point out several generations of capable and successful citizens, while those who are advocating the sciences with but a score of years of laboratory work in this state, have had but this short time in which to perfect methods and train students; it is too soon to expect results, but it seems to me that these answers are at least prophetically conclusive because they unite in advocating discipline first of all, and in addition much useful information.

I have grouped together several of the replies to the third question, "What are the present leading tendencies in secondary scientific education?"

"The present leading tendencies in secondary scientific education are anti-academic; i. e., science for commercial value."

"Away from the technical exactness of university methods toward more general and humanized survey; in closer touch with every-day activities of the commercial and business world."

"The present leading tendency in secondary scientific education is toward the practical and away from pure science. Here in Illinois our biology is being turned toward agriculture, hygiene, etc., and the movement to industrial application in the other science subjects is apparent."

"My opinion is that the tendency is to make all the sciences too commercial; that is, to see everything from the commercial side and toward that goal."

"So far as my observation extends, the present leading tendencies in secondary scientific education are in the direction of a more limited content, greater simplicity of presentation, and closer articulation with the life experiences of the pupil."

"Present tendency toward study of practical application. In the case of physics a return to the methods of Professor Tyndall, i. e., to methods involving an appeal to the imagination through impressive experiments performed by the teacher."

"I should say a recoil from the extreme laboratory methods to more sensible combinations of didactic instruction with laboratory work."

These opinions are all from secondary teachers, the men and women doing the work. It is easy to draw several inferences in regard to the progress of the fads of methodology. A number of the writers like the first four are just in the process of cutting loose from the "technical exactness of university methods," and, rudderless, are blown hither and yon by "humanized survey," "commercial," "hygiene," or utilitarian motives. It is possible that they will have a pleasant sail as long as the water is calm and they do not try to make a landing.

Next we come to some men who have passed through this drifting period and urge simplification. They believe that in trying to teach so much as most of the syllabi outline, there is a distinct loss, and with this view I am in hearty accord. The Regents in this state have tried the extensive plan; it is to be hoped that the present revision will tend toward simplicity. It seems well recognized that a great many of the secondary pupils will be distinguished neither for high attainments nor for useful interests, but rather, as the good lady said, have a "middlin' interest," and these should be kept in mind.

Finally we come to the latest tendency, "the recoil from the extreme laboratory methods." This will be something of a shock to those who advocate that the laboratory is the most important and chief avenue for securing information. This is going to be

a difficult problem to adjust. What shall be the minimum amount of laboratory work? Fifty per cent of the answers to the question, "Should there be more or less laboratory work?" were in favor of lessening the amount that they were at present giving. Those that are satisfied with their present plan are giving from one-half to one-fifth of their time to laboratory work. In the main, then, there is a tendency to limit the amount of laboratory work in secondary science, and to return to the earlier plan of a considerable number of demonstrations.

5. *Should the high school pupil know in a general way something about the principles to be studied before doing his laboratory work; or first make the laboratory experiment, then deduce the principles?*

In practice 80% of the teachers replying believe in presenting something of the principles before going into the laboratory; 5% favored going to the laboratory first. The reason for introducing this problem for discussion is that this latter view was advocated at our last meeting as the best and only right method for secondary pupils. There are two reasons why one would oppose the view referred to. First, this is the method which is so successfully employed in graduate work, and even here it is not uncommon for the first year to be a failure so far as definite results are concerned; but with the graduate student independence and resourcefulness are indispensable requisites for his future degree, no matter how long it takes. When this method is introduced into the average undergraduate class I am sorry to say that it is but partially successful. I believe this to be but the common experience of college teachers. Add to this the testimony of the 80% of practical secondary teachers and the weight of the argument is against this more abstract method.

The second reason why one disapproves of this method is a psychological one. If the evidence of structural neurology has any significance at all it shows that the human brain gradually becomes a more perfect organ; that at certain definite periods of bodily growth there are equally definite changes in the central nervous system. One of these occurring from 14 to 20 years of age is the growth of the so-called tangential fibres, by means of which the several parts of the brain become more perfectly coördinated. We are further led to believe that with these changes the power to do abstract thinking is much enhanced and henceforth becomes a more dominant factor in the operations of the mind. Therefore, it seems manifestly absurd to try to introduce abstract methods of discipline before this period.

Summary.

1. Educators and laymen are criticising our present college preparatory course of study as being unsatisfactory for the majority of high school pupils.

2. The rapid popularization of the sciences and of the laboratory method have caused some of the old problems to assume a new form which will require considerable readjustment.

3. The high schools are apparently paying less attention to distinctively college preparatory work, and in its place are considering courses especially planned for those who never go beyond the high school, while the fact that the colleges are equally independent is evinced by the large number of students who enter with one or several conditions.

4. In reply to the challenge that the sciences are not producing the same breadth of vision and discipline as the time honored subjects, the answers are positive in declaring for sane methods and asserting that the sciences do furnish adequate discipline together with much useful information.

5. The present tendencies of each teacher in secondary science depends upon his individual experience. He may still be under the dominance of his college work, just cutting loose from its technical requirements, or drifting about; or, in his more mature experience, he may be working for simplification and a limited amount of laboratory work.

6. Practical experience and theoretical reasons recommend that the high school student should know something of the things to be studied in the laboratory before beginning his work.

Nickel does not cast well in the pure state, as it absorbs carbon monoxide and then gives it out on cooling, thus causing blowholes. This difficulty is overcome by the addition of a small quantity of magnesium—about ⅛ per cent. Aluminum and phosphorus have been suggested for the same purpose. Copper and nickel alloy readily in all proportions. When added to copper it affects the color but slightly. Until the alloy contains about 30 per cent of nickel, the coppery color is still distinguished, but when the proportion of nickel approaches 40 per cent, the alloy becomes silver white, and continues unchanged in color until the nickel reaches about 80 per cent, after which the color darkens considerably. Copper-nickel alloys are rarely used, except for coinage. German silver includes a large number of alloys containing copper, nickel, and zinc in different proportions, sometimes with the addition of other metals.

THE SCOPE OF HIGH SCHOOL BOTANY.*

By Arabel W. Clark,
Akron High School, Akron, Ohio.

It has been said that in all science there is a bright side, a dark side, and a practical side; and surely no true lover of biology can deny the direct application of this maxim to high school botany.

At a superficial glance everything connected with botany seems all that is bright and beautiful—there is no dark side and the practical phase, if present at all, is rendered charming by its very remoteness. But ask the real and ardent student—he who sees, knows, and understands the practical and the beautiful. To him the dark side is so magnified that the whole subject is misshapen into a scientific deformity.

And what is this dark side? It is a true and full realization that botany is not presented to the high school curriculum on a natural and practical basis and therefore can never create a seeing, a feeling, a thinking, a reasoning, an appreciation of and a communication with, nature in its truest, highest, and most beautiful light.

Botany heretofore has been largely a study of flowers. It should be a study of plants, plants as living, striving organisms, throbbing with vitality. In teaching a class of New York City slum children, Jane Addams once referred to the *country*. From the puzzled expressions, she at once realized that to these pupils, many of whom had never seen a tree, the word *country* was a blank. Upon asking what the country was, one little volunteer replied: "Oh, the country is a place where the grass sticks up through the ground." To most of us this is just what the country implies, a place where grasses and trees and shrubbery stick up through the ground. Whether we sail over, ride through, or saunter in the country, the results are all the same. We have been taught from the kindergarten and the infant classes in the Sunday School up, that God made the flowers because they were beautiful, and he made them beautiful for us to look at. Not a single word is breathed of their struggles, of their functions, of their development, of their wonderful and all-important activities. Not a single hint is ventured that if he had not made them, he would have made us different or not at all.

Yes, surely, as pitiful as the case may be, to most of us, "The country is a place where the grass sticks up through the ground."

*Read before the science section of the Northeastern Ohio Association of Science and Mathematics Teachers, Dec. 11, 1909.

But more is the pity that we, as high school teachers, should be doing so little toward overcoming the situation.

The whole plan of high school biology should be developed along the line of *organic evolution.* Proceed from the simple to the complex and emphasize *differentiation, division of labor* and *sexual development.* Botany, however, must be dealt with very differently from zoölogy. From grade physiology, the pupil enters the high school with a rather definite idea of animal tissues and their functions. All the main life processes—eating, breathing, digestion, assimilation, excretion, sleeping, moving, reproduction—he is already acquainted with. He may at once be introduced to the amœba, and from thence can intelligently follow the animal kingdom along the lines of organic development.

The botany teacher, however, faces an entirely different proposition when she presents her subject to the high school sections. Here are pupils each of whose knowledge of botany is usually limited to about three facts: 1st, the names of some five or ten flowers, common to the particular locality in which he was reared; 2nd, pollen is carried by bees; 3rd, plants give off oxygen and take in carbon dioxide in the breathing process. This last factor is usually so overly well grounded that many hours of drill, patience, skill, yes, of strategy must be expended on the part of the teacher before the pupil will be sufficiently convinced of its incompleteness to admit even a minor amendment to his early established law.

It is plain that the botany teacher has little to start with. She is forced to begin at the very bottom and "build the ladder on which she climbs." Her first step must be to establish an understanding of the plant activities, and to do this she introduces the plant as a whole. She divides it into three parts—the leaf, the root, and the stem. Separately she takes up the principal life functions of these organs, and their structure in so far as necessary to a perfect understanding of the vital activities. Later she shows the relation of these functions to each other, to the plant as a whole, to its natural environment, to animals, especially to man. This includes the study of variation, struggle for existence, survival of the fittest, and adaptation.

The question now arises, how much time must be given to this part of the work, how much to text, how much to laboratory, and what part does the microscope play? In a twenty weeks' course, the first six weeks are required for this phase of

the subject; two-thirds of this should be used in recitation and one-third in laboratory. Let the laboratory work *follow* the text; make this a period of application and impression not of exploration and discovery. There is neither time nor place for research among ninth and tenth grade pupils. The compound microscope has little use in high school botany. It should never be placed at the disposal of the pupils, as its only value in this work is for verification and observation of the minute details in the little histology that is offered. The teacher may set up particular slides and find time for individual instruction during laboratory periods. For this phase of the subject just mentioned, two microscopic observations should be sufficient for a clear understanding of the work: one to show the living cell and the arrangement of tissues in the cross section of a leaf; and the other to show the same in a longitudinal section of a root tip.

The child after six weeks is acquainted with the structure of tissues and the principal life processes of the plant. Since these principals and processes are the same throughout the vegetable kingdom, he is ready to proceed in the order of complexity. Starting with the simplest plants, and applying the type method throughout the groups, this division of the work can be covered hastily and effectually up to the group of flowering plants, or Angiosperms. Throughout the work, special attention must be given to the development of structure, of function, of methods and complexity of reproduction, to ecology, and to economy. Each group should be left with a thorough understanding of its life history, and the whole summed up under the head of organic evolution. The last two months may be given to the Angiosperms. Since in our preliminary study all necessary physiology and morphology were taken up, we may now devote our time to the flower and seed. And, indeed, the pupil is prepared to take hold of this subject in a true and knowing spirit. The flower stands for something beside beauty, fragrance, and frailty. It is no longer simply an ornament to be plucked, dissected, analyzed, discarded. It is a real, living, sensitive organ with a vital and clearly developed function. It is this knowledge, this appreciation, this spirit, which makes botany the really beautiful science; for the most inconspicuous blossom, the most unsymmetrical flower, and the vilest smelling weed are as sacred to the naturalist as a rose.

One day I had furnished each pupil of a ninth grade class with a carnation to study the development of the petal from the

stamen. When it came time to dissect the blossom, one little girl hesitated in pulling out the petals. That flower was so real, so living, so perfect a structure to her, that she would almost as soon have pulled a live earthworm in two. It is this all-important appreciative spirit which to-day is lacking in high school botany, and it is lacking because of the methods used in teaching the subject. It is not that insufficient energy is put into the work, but it is the lamentable fact that this energy is ill-advised and misdirected. Too much time is spent on form and detailed measurement. Just so the general structure in respect to functions and relations is understood, what difference does it make about the size and shape? What could be more useless and ridiculous in physiology classes than to measure the length of each child's chin, the height of his forehead, the breadth of his nose, the curvature of his cheeks? Is it necessary to classify noses into straight, flat, pug? Yet in botany many of us are running a parallel absurdity in measuring leaves, in presenting all available shapes with the greatest combination of grotesquely outlined edges, and applying and requiring to be memorized the most outlandish names. Wherein lies the value?

In three cities in as many states, I have taught botany and each city has claimed for itself most abundant flora and the greatest variety of rare flowers in the United States. With this as an excuse, the high school pupils have been required yearly to gather great numbers of these rare and other specimens to be placed in their private herbariums.

Personally I have never been convinced of the profits of herbariums. Many rare plants have been exterminated in some localities as a result of this craze. Herbariums are a waste of time and mechanical energy. What true scientific power and reasoning ability is to be gained by a pupil's digging a plant up by the root, cleansing it, placing it between blotters under heavy weights, later sticking it neatly to a sheet of mounting paper, and writing beneath its name and its position in the vegetable kingdom? It is an impossibility for the average high school student to do this for himself. Where large herbariums are required, I have heard more than one teacher say that during the herbarium season, she was hoarse and bodily weary just from the physical exertion of naming plants. There is little virtue in any process where the teacher loses and the pupil does not gain.

And after the botany work closes, what use is ever made of the herbarium? In a few years the specimens are so moth-eaten,

ragged, and discolored that they cannot even be recognized. Hundreds of times one hears the remark: "I have quite a large herbarium in the attic, but I haven't looked at it since I made it as a child." And the chance one who might inspect his after many years, might find delight in the memory of early associations but certainly none in the faded collection of mutilated specimens. Flowers are everywhere, and they bloom every year. Surely the pleasure we get from a freshly blooming specimen can easily eclipse that we get from glancing through an herbarium of decaying plants.

Because the flowering plants are the most conspicuous and most numerous group, why should there be such a strong tendency to study them exclusively and either slight or religiously avoid the lower forms of the plant kingdom? Surely the study of the wild rose is no more important to man than that of bacteria. Should the child not know about yeast, the formation of vinegar, the decaying of fruits, the working of preserves, the moulding of bread, the growth of the mushroom, the rusting of wheat, the nodules of clover roots, the germs of common contagious diseases, the algae in our aquariums, in our reservoirs, and on our very doorsteps? The material for the study of these lower forms is about us abundantly and constantly, and our very existence is dependent upon them. Flowering plants although most important are not all-important, and their study should not be encouraged to the neglect of the equally interesting lower forms.

What we need then in our study of high school botany is a new method of attack along the line of evolution with a substitution of useful for useless work. This method would not only assure a rich and scientific appreciation of nature in a popular sense, but would furnish a systematic outline to develop all the common practical relations between man and the vegetable kingdom. Placed upon such a natural, logical, and practical foundation, there could be no dark side to botany. Only the truly bright and beautiful could be in evidence and the country would no longer be "a place where the grass sticks up through the ground."

The copper production of the Butte district in 1909 will exceed that of any previous year in the history of Butte. That is the statement of an officer of the Amalgamated Copper Co. The production will considerably exceed 300,000,000 pounds. But for the December curtailment, due to the strike of railroad switchmen, the output would have been close to 320,000,000 pounds.

SOME GOOD PLANT DEMONSTRATIONS THAT ARE NOT INCLUDED IN THE USUAL TEXT-BOOKS.

By F. L. Pickett,
High School, Bloomington, Ind.

1. The cobalt test for showing stomatal transpiration. Use leaf of Nerium, oleander, Ficus elastica, or any smooth begonia —preferably attached to a thriving plant. Attach strips of thoroughly dried cobalt paper to either side of the leaf by means of two thin object slides and small rubber bands. After 10-20 minutes the paper on the lower side of the leaf will show a decided pink tint and in many cases will have lost all appearance of blue, while the paper on the upper surface should show no change.

Previous examination of these leaves—with the compound microscope—will have shown the presence of stomata on the under side and not on the upper. In order to make the experiment a success it is necessary to select a leaf for use on the upper side of which there are no stomata, or at least a very few stomata.

Caution: Use only smooth leaves, and be careful not to break the epidermis. It is almost impossible to prevent the crushing of plant hairs on leaves that have them.

Note: Cobalt paper is made by soaking clean filter paper in a 5-10 per cent solution of cobalt chloride and afterward thoroughly drying it.

This experiment is well known among plant physiologists, and has been much used since its presentation by Stahl in 1894. See also Detmer-Moor, 2nd Ed., pp. 214. It has not been recognized by authors of high school texts and manuals. To the writer it seems the simplest and most conclusive means of proving stomatal transpiration to elementary students.

2. To show the general fact of transpiration and the flow of water to leaves.

A vigorous branch of Ricinus was attached to a glass tube which was drawn out to about 1 mm. diameter and placed in a 100 cc. cylinder as shown in the figure. Attach the rubber connecting tube first to the glass tube, then by pressing the cork into the cylinder, the water may be forced up so there will be no air below the stem. Be careful to have the joints tied tightly or sealed with vaseline to allow no air bubble to remain in the connecting tube, and to have the cork fit loosely enough to allow air to enter to take the place of water flowing to the leaves.

FOREIGN TRADE AND THE METRIC SYSTEM.

The following statistics and comments concerning exports and imports between the United States and metric and non-metric countries have been compiled by a correspondent. A comparison of the growth, especially of exports, to countries in which the customs duties are reckoned by the metric system shows conclusively why, in order to promote foreign trade, the United States should speedily adopt this system in its customs duties. Some day the great force of this argument will dawn upon business men and manufacturers, and then a sudden stampede to the international system in customs duties will not be surprising. An up-to-date list of metric and non-metric countries follows.—ED.

There has been a marked change in recent years in the foreign trade of the United States in respect to the distribution of it between countries that do, and those that do not, use the metric system. Comparing the proportions from year to year the metric part has overtaken and passed the non-metric. I have endeavored to make this conspicuous in the accompanying tabular statement based upon the published statistics of commerce by countries. I have divided the countries into two classes, as shown on appended table, adopting as the criterion their official adoption or non-adoption for customs service of the metric system. My non-metric class includes Abyssinia, China, Japan, Liberia, Morocco, Persia, Russia, and Siam, with Great Britain and all her possessions. Separating into two corresponding classes the exports from the United States as expressed by their values, it appears that during the last five years the proportion of my metric class has increased pretty steadily and come to be more than half.

EXPORTS

Fiscal Year ended June 30	IN MILLIONS OF DOLLARS			
	To Countries with Metric Customs Service	To Other Countries	DIFFERENCE	
			Preponderance Metric	Preponderance Other
1905	653	865	—	212
1906	824	920	—	96
1907	919	961	—	42
1908	932	928	4	—
1909	841	822	19	—

THE EFFECT IS EQUIVALENT TO HAVING UPWARDS OF ONE HUNDRED MILLION DOLLARS' WORTH OF GOODS WHICH A FEW YEARS AGO WENT TO THE NON-METRIC COUNTRIES NOW GO TO THE METRIC COUNTRIES ANNUALLY. The natural inference is that a great number of persons engaged in the production of merchandise in the United States are brought into this trade relation preponderating with countries that maintain the metric system of weights and measures. This I regard as affording a practical basis for securing for the adoption of the metric system in the United States a degree of attention in commercial circles which it has hitherto been found difficult to obtain. This is a business matter which should appeal to business men, whereas other grounds which I believe to be more important and convincing in favor of metric reform have not always received from business men the attention which they ought to have had.

I suppose that the simple explanation of the commercial change here pointed out is that the United States has increased in recent years its production of manufactured goods, and has found a market for them more in the countries which have, than in those which have not, officially adopted the metric system in their custom houses (particularly Great Britain, for the obvious reason that Great Britain is a manufacturing country and requires relatively little manufactures from the United States).

As to the *imports* into the United States, the proportion has changed less during past years. I extend my tabulation so as to include imports also, and I take the sum of the values of imports and exports to represent the total trade. Comparing my metric and non-metric divisions of the total trade shows that there has been a pretty steady increase in the metric proportion for years. It has risen from 50% to 55% since 1902, as shown in the following table.

Fiscal Year Ended June 30	IN MILLIONS OF DOLLARS						Proportion Classed as Metric in the Whole
	EXPORTS		IMPORTS		SUM OF EXPORTS AND IMPORTS		
	To Countries with Metric Customs Service	To Other Countries	From Countries with Metric Customs Service	From Other Countries	To or From Countries with Metric Customs Service	To or From Other Countries	
1903	614	806	616	409	1230	1215	50.3%
1904	649	812	614	377	1263	1189	51.5%
1905	653	865	703	415	1356	1280	51.4%
1906	824	920	754	473	1578	1392	53.1%
1907	919	961	868	567	1787	1528	53.9%
1908	932	928	726	469	1658	1397	54.3%
1909	841	822	811	501	1652	1323	55.5%

The increase of the metric proportion appears to be still going on and likely to continue, as the causes of it are expected to remain active. At an earlier time the non-metric trade was greater than the metric. Still earlier our trade with the British Empire alone constituted more than half of our foreign trade. Earlier still our trade with only the United Kingdom of Great Britain and Ireland was more than half. This may be regarded as the natural consequence of the fact that England was our mother country. Our trade with Great Britain, though still of much money value, consists in great part of our exports of materials, such as raw cotton and meat products, for which uniformity in weighing and measuring has not the same importance as for articles manufactured to sizes; a large proportion of it is in goods like breadstuffs and oils, measured by bushels and gallons in which there is a difference of magnitude between the United States and Great Britain.

The press has recently represented that the Bureau of American Republics was engaged in the preparation of matter for a basis of action to promote closer relations between the United States and the other American republics, and that the policy pursued was to follow courses in which harmony among the different nations was to be found. Now, it is obvious that it would tend to facilitate trade relations between the United States and the other republics to have the United States adopt the metric system in its own custom houses, as recommended at various times and particularly by the secretary of state, James G. Blaine, July 12, 1890, in connection with the report of the first Pan-American Conference, so-called, of which he was the honorary president; and it is a fact that this subject is about the only one of those which have been considered in the Pan-American Conferences upon which there has not arisen some divergence of opinions, obstruction in the way of progress or occasion for delay of action. My single point, that *in the foreign commerce of the United States the metric proportion has conspicuously increased,* is put forward to show that conditions now existing are different from the conditions of the time when the Pan-American Conferences took up the subject of metric reform.

The press has recently represented also that a new bureau or division was expected to be organized in the state department to attend to the trade relations of the United States with the other American republics, Secretary of State Knox being named in this connection as well as President Taft. Under the preced-

ing administration Secretary Root, in connection with the Pan-American Conference at Rio Janeiro, made an extended journey to the principal capitals of South America and assured their people of the respectful consideration of the United States. It would be well for the people of the United States to try to live up to the ideal proposed by Secretary Root in that particular. The United States invited the representatives of the other American governments to the first of the Pan-American Conferences; the United States proposed for its consideration the subject of uniform weights and measures; the United States had its representative upon the special committee to which the subject was assigned; the committee reported unanimously and its report

Classification of Foreign Countries as to their Official Adoption of Metric Weights and Measures for Customs Service.

With Metric Customs Service		Other Countries
Austria-Hungary	Brazil	Gibraltar
Azores and Madeira Is.	Chile	Malta, Gozo, etc.
Belgium	Colombia	Russia in Europe
Denmark	Ecuador	Great Britain and Ireland
France	Dutch Guiana	Bermuda
Germany	French Guiana	British Honduras
Greece	Paraguay	British North America
Greenland, Iceland, etc.	Peru	Newfoundland and Labrador
Italy	Uruguay	British West Indies
Netherlands	Venezuela	British Guiana
Norway	French China	Aden
Portugal	German China	Chinese Empire
Roumania	Dutch East Indies	British China
Servia	French East Indies	Japanese China
Spain	Turkey in Asia	British East Indies
Sweden	French Oceanica	Hong Kong
Switzerland	German Oceanica	Japan
Turkey in Europe	Philippine Islands	Korea
Costa Rica	Canary Islands	Persia
Guatemala	French Africa	Russia Asiatic
Honduras	German Africa	Siam
Nicaragua	Italian Africa	All other Asia
Panama	Kongo Free State	British Australasia
Salvador	Madagascar	New Zealand, etc.
Mexico	Portuguese Africa	British West Africa
Miquelon, Langley, etc.	Spanish Africa	British South Africa
Cuba	Turkey in Africa-Egypt	British East Africa
Danish West Indies	Tripoli	Liberia
Dutch West Indies		Morocco
French West Indies		
Hayti		
San Domingo		
Argentine Republic		
Bolivia		

was adopted by the conference with complete harmony and transmitted with Secretary Blaine's recommendation of action in the United States customs service, as just above stated. Why should there be any delay about the United States government's putting into effect the project which it initiated itself, now that the greater part of the trade passing under the cognizance of the United States customs service is with metric countries? How would further delay strike the Latin American delegates? Anyone who supposes that the statesmen of Latin America would be incapable of perceiving if they were treated with contempt, is densely ignorant of their characteristic qualities.

DEPARTMENT OF GEOGRAPHY, ENGLEWOOD HIGH SCHOOL, CHICAGO.

By Kenneth C. Fitch.

Five rooms are now being used for the teaching of geography at the Englewood High School. They comprise three laboratories, one recitation room and a preparation room. In these rooms are handled on the average about fifteen classes in physiography and physiology, three classes in commercial geography, and a class in astronomy and geology.

As only one class room is available, most of the recitation work is done in the laboratories. These are quite similar in construction and equipment, and hence only one will be described.

The room occupies the northwest corner of the building on the first floor and is about 24x48 feet in size.

There are three large tables provided for pupils, each having seven numbered drawers on a side and seating fourteen pupils. A shelf across the west end of the room will accommodate about five more pupils, although the classes are generally kept under forty. The teacher's desk occupies a platform in the southeast corner of the room, and in the northeast corner is a delta table of the standard Chicago form.

Along the entire north wall, under the windows, are dustproof cases with glass tops and sides for the display of rocks and minerals. Cupboards and drawers, to most of which the pupils have access, line the south wall. The room can be darkened by black shades which are provided in addition to the usual green ones. There are three sliding blackboards.

The equipment is quite complete for the handling of physiography as it is taught at present in good secondary schools.

Most important of all is a lantern with electric connections and about two hundred slides. The wall space above cases and between windows is utilized for physical maps of the continents, pictures of physiographic features and coast survey charts.

Among the pieces of demonstration apparatus are: a twelve-inch globe of the earth, a slate globe of the same size, a good barometer, barograph, maximum and minimum thermometer, wet and dry-bulb hygrometer, and a hygrodeik. For physical and chemical demonstrations there are flasks, ring stands, glass and rubber tubing, etc., and a supply of mercury. Gas connections can be made above each table.

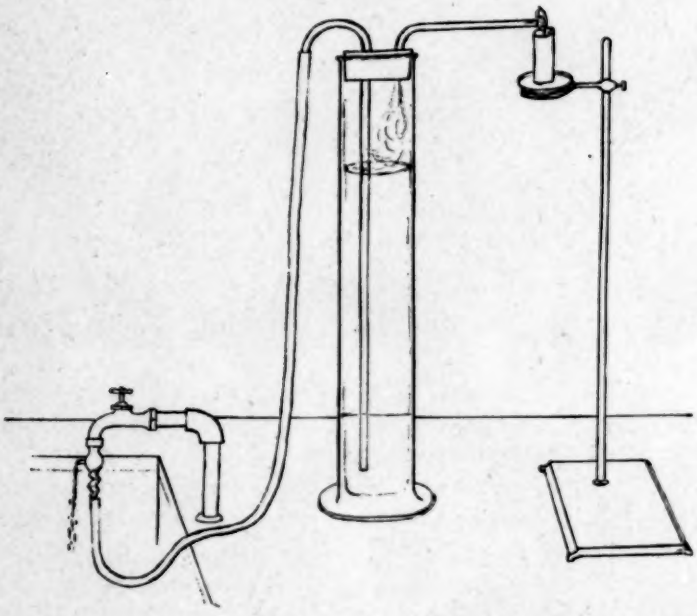
About thirty duplicate pieces of equipment are provided for the pupils' individual work. Some of the more important of these are: an unusually complete supply of rocks and minerals, six-inch mounted globes, bar magnets, hand magnifiers, protractors, rulers, acid bottles with glass rods, topographic maps and Chicago folios. The equipment is sufficient for all the pupils' and teacher's exercises contained in the manual which was recently prepared by the Chicago teachers.

A CONVENIENT APPARATUS FOR PROVING THAT A FLAME IS BURNING GAS.

By J. M. Arthur,

The Tome School, Port Deposit, Md.

The experiment shown in the drawing is offered as an improvement upon the one by Lassar-Cohn in his "Chemistry of Daily Life." The essential to the improvement is the aspirator, although a glass T tube inserted in its place would answer as well.



The method of operation is as follows: The water-cock is opened and water run into the cylinder until it is full. As soon as the cock is closed, water begins to siphon back into the sink through the air-inlet of the aspirator. The candle should be lighted and in readiness to be placed at the mouth of the tube leading to the cylinder. The water, at the beginning of the flow, should be made to siphon slowly by compressing slightly the rubber portion of the siphon. When the cylinder is full of the cloudy gas, the candle is removed, the water-cock again opened slightly, and the entering water forces the gas from the upper outlet where it can be lighted by a touch of the candle flame.

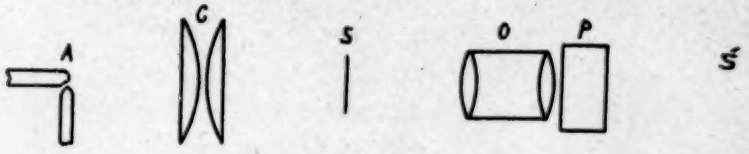
SOME DEMONSTRATION EXPERIMENTS IN SELECTIVE ABSORPTION.

E. J. RENDTORFF,

Lake Forest Academy, Lake Forest, Ill.

I wish to present several experiments on selective absorption, the last of which may be new to many of our teachers. The first two are known to all. They are mentioned merely to complete the series.

With the stereopticon project a slit, S, on a screen S'. The slit should be placed at the focus of the condensing lenses, C, to obtain the proper illumination. Place a CS_2 prism, P, in front of the objective, O, and then throw the spectrum on the screen, either by reflection from a plane mirror, or by rotating



the lantern through the angle of deviation of the prism. For the best results the prism should be placed in the position of minimum deviation.

In case a CS_2 prism is not accessible use an Ives or Wallace transmission grating. The prism is recommended on account of the greater dispersion and luminosity of the spectrum.

A. The selective absorption of the visible spectrum is shown by holding in front of the slit various colored glasses, liquids, or analine dyes on a glass plate. A red glass absorbs all but the red end of the spectrum, etc. The theory of color in transparent media can now be fully developed and the student prepared for understanding of the Fraunhofer absorption lines in the sun's spectrum.

B. The selective absorption of opaque bodies and the consequent reflection of the unabsorbed waves is best illustrated by holding various colored pieces of paper, such as red, green, and blue, in different parts of the spectrum. Thus the red paper appears its sunlight color in the red end of the spectrum, but black in the other parts, due to selective absorption. The student thus perceives that the color of opaque bodies is due to the reflection of the waves not selectively absorbed.

C. Selective absorption of heat rays.

Hold a Crookes' radiometer some 20 cm. from the front condenser lens and project it on the screen. Note the rate of revolution of the vanes. This rate is a function of the heating effect of the incident heat rays, coming from the electric arc. Now hold a glass pneumatic trough, filled with water, between the condenser and the radiometer. The luminosity of the image of the radiometer is not perceptibly diminished, showing that there is but a small absorption of the light rays.

The rate of rotation of the radiometer vanes, however, diminishes at once and comes almost to rest, showing that the invisible ultra red heat rays are absorbed by the water.

Repeat the above experiment substituting a plate of rock salt for the trough of water. No perceptible change of any kind is noticeable. The rock salt is apparently transparent to both heat and light waves.

D. Reflect the light of an electric arc from a concave mirror and pass it through the piece of rock salt and a piece of glass of the same thickness. After several minutes place the plates alternately against one face of a Nobili thermopile connected to a demonstration galvanometer. The deflection caused by the rock salt plate is decidedly less than that produced by the glass.

The waves selectively absorbed are therefore transformed to heat in the absorbing body.

E. Again note the rate of rotation of the radiometer. Place a small absorption trough, some 1 cm. thick, containing a solution of iodine in CS_2, between the radiometer and condenser. The radiometer is now barely seen, as the visible rays are almost entirely absorbed, but it rotates with undiminished speed. Why? Because the iodine solution selectively absorbs the visible rays, but is transparent to the longer heat rays.

F. Focus the light from the lantern on a mercury thermometer. It will register over 110° C. Next hold at the focus a sooted accessory bulb of the thermoscope described in the December, 1909, number of SCHOOL SCIENCE AND MATHEMATICS. The indicator liquid will soon register above 30 cm., the limit of the thermoscope. Now remove the sooted bulb and substitute a thoroughly clean one. Much to our surprise the thermoscope will register but 2 mm. Why?

After passing through the two condenser lenses and several feet of air the rays that would heat the glass accessory bulb and its enclosed air are absorbed and the filtered rays produce no further heating, but when the bulb is covered with soot a new set of waves are absorbed with a consequent heating effect.

PROBLEM DEPARTMENT.

E. L. BROWN.

Principal North Side High School, Denver, Colo.

Readers of the magazine are invited to send solutions of the problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott St., Denver, Colo.

Algebra.

190. *Proposed by Walter L. Brown, Albion, N. Y.*

Prove that no four square numbers can be in arithmetical progression.

I. Solution by Norman Anning, Chalhwick, B. C., Canada.

The expressions $(m+n)^2$, m^2+n^2 and $(m-n)^2$ are in A. P. All will be square numbers if we choose m and n so that the second is a square number. Hence there will be a solution of Problem 172 corresponding to each solution of the Pythagorean equation $m^2+n^2=l^2$. All the essentially different solutions of this latter are obtained by putting $m=a^2-b^2$ and $n=2ab$ where a and b are relatively prime and not both odd. With the same restrictions on a and b, all the solutions of Problem 172 are included in the statement that $(a^2+2ab-b^2)^2$, $(a^2+b^2)^2$, and $(a^2-2ab-b^2)^2$ are three square numbers in A. P. The common difference is $4ab(a^2-b^2)$.

If it be possible to find four square numbers which are in A. P. it must be by extending the above A. P. to a fourth term. Suppose this is done by adding the difference, $4ab(a^2-b^2)$, to $(a^2+2ab-b^2)^2$. The resulting expression,

$$a^4+8a^3b+2a^2b^2-8ab^3+b^4=(a^2+4ab-7b^2)^2+48b^2(a-b),$$

is a perfect square only when $48b^2(a-b)=0$; that is when $b=0$ or $b=a$. Each of these leads to a degenerate A. P. in which the common difference is zero. Similar reasoning applies when $4ab(a^2-b^2)$ is subtracted from $(a^2-2ab-b^2)^2$. Hence the statement of the problem that no four square numbers can be in arithmetical progression.

II. Solution by I. L. Winckler, Cleveland, Ohio.

Let x^2, $(x+m)^2$, $(x+n)^2$ be three square numbers in A. P.

$(x+m)^2-x^2=2mx+m^2$ is the difference between the second and the first terms. Therefore $(x+n)^2+2mx+m^2$ must be a perfect square if there can be four numbers in A. P. This expression equals

$$x^2+2(m+n)x+m^2+n^2$$

and if it is a perfect square we must have $\sqrt{m^2+n^2}=m+n$, which is impossible.

191. *Selected*

If $$u_1=\frac{Mu+M'u'}{M+M'}-\frac{eM'}{M+M'}(u-u'), \quad \ldots\ldots(1)$$

and $$u'_1=\frac{Mu+M'u'}{M+M'}+\frac{eM}{M+M'}(u-u'), \quad \ldots\ldots(2)$$

prove $$Mu_1^2+M'u_1'^2=Mu^2+M'u'^2-\frac{(1-e^2)MM'}{M+M'}(u-u')^2 \ldots\ldots(3)$$

Solution by H. E. Trefethen, Kent's Hill, Me., and G. B. M. Zerr, Philadelphia, Pa.

Since the given equations are of the form $u_1=p-M'q$ and $u_1'=p+Mq$, square each, multiply respectively by M and M'. Then adding we get $Mu_1^2+M'u_1'^2=p^2(M+M')+MM'q^2(M+M')$

$$=\frac{(Mu+M'u')^2}{M+M'}+\frac{e^2MM'}{M+M'}(u-u')^2$$

$$=Mu^2+M'u'^2-\frac{(Mu^2+M'u'^2)(M+M')}{M+M'}+\frac{(Mu+M'u')^2+e^2MM'(u-u')^2}{M+M'}$$

$$=Mu^2+M'u'^2-\frac{(1-e^2)MM'}{M+M'}(u-u')^2$$

Geometry.

192. *Proposed by W. G. Baab, Charles City, Iowa.*

Within a circle whose diameter is 50 there are inscribed three equal circles, each of the four circles being tangent to the other three. Find (a) the radius of the inscribed circles, and (b) the area of the large circle not included by the small circles.

I. Solution by H. L. McAlister, Arkadelphia, Ark., and Chas. T. Moore, Columbus, O.

Let R=radius of large circle, r=radius of each small circle. The centers of the small circles are the vertices of an equilateral triangle whose sides are $2r$. The common tangents to the small circles at their points of contact are the medians of this triangle and intersect at the center of the large circle.

$\therefore \frac{2r\sqrt{3}}{3}$ = distance of center of each small circle from the center of the large circle.

$\therefore R=r+\frac{2r\sqrt{3}}{3}=25.$

Solving, $r=25(2\sqrt{3}-3)=11.603.$

Area of three small circles$=625\pi(21-12\sqrt{3})\times 3.$

Area of large circle$=625\pi.$

$\therefore$ difference in area$=625\pi(36\sqrt{3}-62)=694.743.$

II. Solution by Orville Price, Denver, Colo.

Radius of small circle found as in Solution I.

Let O be center of large circle, C_1, C_2, C_3 centers of small circles. Let C_1 and C_2 touch at L, C_2 and C_3 at M, C_3 and C_1 at N. That part of the large circle included by the small circles may be construed to mean not only the areas of the three small circles, but also the area of the triangular-shaped figure LMN.

Hence the total area included by these small circles equals area of triangle $C_1C_2C_3$ plus five-sixths of each of the three equal circles.

Area of large circle=1963.50.

Area of a small circle=422.9536.

Area of triangle=233.179.

Let D=required area.

$\therefore$ D=1963.50$-$(233.179$+3\times\frac{5}{6}$ of 422.9536)=672.94.

Area of triangular-shaped figure LMN is equal to area of triangle $C_1 C_2 C_3$ minus one-half area of one of the small circles. $\therefore$ LMN=21.80.

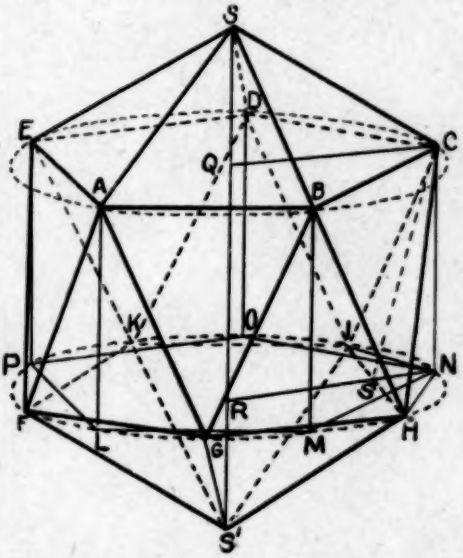
193. *Proposed by Charles T. Moore, Columbus, Ohio.*

If a be an edge of a regular icosahedron, V its volume, r the radius of inscribed sphere, and R the radius of circumscribed sphere, show by elementary geometry:

$$(1)\ r=a\sqrt{\frac{7+3\sqrt{5}}{24}},\quad (2)\ R=a\sqrt{\frac{5+\sqrt{5}}{8}},\quad (3)\ V=\frac{5a^3}{12}(3+\sqrt{5}).$$

I. Solution by I. L. Winckler, Cleveland, O.

Consider the rectangle EDHG two of whose sides are parallel edges of the icosahedron and whose other sides are diagonals of a regular pentagon whose side is a.



Let EG=DH=d. In the pentagon SEFGB we have by Ptolemy's Theorem, $d^2=a^2+ad$.

$\therefore\ d=a/2(\sqrt{5}+1)$.

The radius of the circumscribed sphere is one-half the diagonal EH.

$EH^2=EG^2+GH^2=d^2+a^2$

$\therefore 2R=\sqrt{a^2/4(\sqrt{5}+1)^2+a^2}$

$=a/2\sqrt{10+2\sqrt{5}}$

or $R=a\sqrt{\frac{5+\sqrt{5}}{8}}$.

The radius, r, of the inscribed sphere is the altitude of a pyramid whose base is an equilateral triangle, side $= a$, and each of whose lateral edges $=$ R. This altitude is easily found to be

$$\sqrt{R^2-\frac{a^2}{3}}.\quad \therefore\ r=a\sqrt{\frac{7+3\sqrt{5}}{24}}.$$

Area of one face$=\frac{a^2}{4}\sqrt{3}$, and entire surface$=5a^2\sqrt{3}$.

$$\therefore\ V=\frac{5a^2}{3}\sqrt{3}\times a\sqrt{\frac{7+3\sqrt{5}}{24}}=\frac{5a^3}{12}(3+\sqrt{5}),\ \text{since}$$

$$\sqrt{7+3\sqrt{5}}=\frac{3+\sqrt{5}}{\sqrt{2}}.$$

II. Solution by John A. Hardin, Ft. Bliss, Texas.

Let s and s' be two diametrically opposite vertices of the regular icosahedron; they are also the vertices of two congruent regular pyramids whose lateral edges and sides of bases are a, and whose pentagonal bases lie in parallel planes. Let SQ=h be the altitude of one of these

pyramids and CN=p the distance between the planes of their bases. Then obviously R=$h+\frac{1}{2}p$.

QC, radius of the regular pentagon whose side is BC=a,

is $\frac{a}{10}\sqrt{50+10\sqrt{5}}$. Hence $h=\sqrt{a^2-\frac{a^2}{100}(50+10\sqrt{5})}$.

Simplifying, $h=\frac{a}{10}\sqrt{50-10\sqrt{5}}$.

In the right triangle CNS, CN is the distance between the parallel planes, SN is the difference between the radius, RN, and the apothem, RS, of the regular pentagon, and the hypotenuse CS is the altitude of CIH, one of the equilateral triangles.

$$\text{RS}=\frac{a}{10}\sqrt{25+10\sqrt{5}} \quad \therefore \text{SN}=\frac{a}{10}\left(\sqrt{50+10\sqrt{5}}-\sqrt{25+10\sqrt{5}}\right)$$

$$\therefore p^2=\text{CN}^2=\text{CS}^2-\text{SN}^2=\frac{3a^2}{4}-\frac{a^2}{100}\left(\sqrt{50+10\sqrt{5}}-\sqrt{25+10\sqrt{5}}\right)^2$$

Whence $p=\frac{a}{10}\sqrt{50+10\sqrt{5}}$.

$$\text{R}=h+\tfrac{1}{2}p=\frac{a}{10}\sqrt{50-10\sqrt{5}}+\frac{a}{20}\sqrt{50+10\sqrt{5}}=a\sqrt{\frac{5+\sqrt{5}}{8}}$$

Obviously, r is a leg of a right triangle whose other leg is $\frac{a}{3}\sqrt{3}$ and whose hypotenuse is R.

$$\therefore r^2=a^2\left(\frac{5+\sqrt{5}}{8}\right)-\frac{a^2}{3}=\frac{a^2}{24}(7+3\sqrt{5})$$

$$r=a\sqrt{\frac{7+3\sqrt{5}}{24}}.$$

V is equal to the sum of the volumes of 20 triangular pyramids whose bases are equilateral triangles of side a and whose altitudes are r. $\therefore \text{V}=\frac{5a^3}{12}(3+\sqrt{5})$.

NOTE.—The points of tangency of the faces of a regular icosahedron and the inscribed sphere are the vertices of a regular dodecahedron. This relation between these two regular figures is mutual.

The figure for this problem was constructed by Mr. R. S. Howlett, Denver High School, North Side.—ED.

APPLIED MATHEMATICS.

194. *Proposed by Wm. B. Borgers, Grand Rapids, Mich., and E. B. Escott, Ann Arbor, Mich.*

What function of t is Θ when $\frac{d\Theta}{dt}=a^4-\Theta^4$?

This formula is an expression of Stefan's law that the rate at which a body loses heat is proportional to the fourth power of its absolute temperature. Let Θ = the absolute temperature of a body, a = absolute temperature of the surrounding medium, and t = time. Then, choosing such units as will eliminate proportionality factors, the rate at which the temperature of the body falls is $\frac{d\Theta}{dt}=a^4-\Theta^4$.

I. Solution by H. E. Trefethen, Kent's Hill, Me.

$$dt=\frac{d\theta}{a^4-\theta^4}=\frac{d\theta}{2a^2(a^2+\theta^2)}+\frac{d\theta}{4a^3(a+\theta)}+\frac{d\theta}{4a^3(a-\theta)}.$$

Integrating we have

$$t=\frac{1}{2a^3}\tan^{-1}\frac{\theta}{a}+\frac{1}{4a^3}\log\frac{a+\theta}{a-\theta}+c$$

$$=\frac{1}{2a^3}\left(\frac{\theta}{a}-\frac{\theta^3}{3a^3}+\frac{\theta^5}{5a^5}-ect.\right)+\frac{1}{4a^3}\left(\frac{2\theta}{a}+\frac{2\theta^3}{3a^3}+\frac{2\theta^5}{5a^5}+ect.\right)+c$$

$$=\frac{1}{a^3}\left(\frac{\theta}{a}+\frac{\theta^5}{5a^5}+\frac{\theta^9}{9a^9}+ect.\right)+c$$

Reverting this series

$$\theta=a^4(t-c)-\frac{a^{16}(t-c)^5}{5}+\frac{4a^{28}(t-c)^9}{45}-\frac{134a^{40}(t-c)^{13}}{2925}+ect.$$

II. Solution by Orville Price, Denver, Colo.

$$dt=\frac{d\theta}{a^4-\theta^4}=\frac{1}{4a^3}\left[\frac{d\theta}{a+\theta}+\frac{d\theta}{a-\theta}+\frac{d\theta}{a+\theta i}+\frac{d\theta}{a-\theta i}\right],\text{ where } i=\sqrt{-1}.$$

Integrating, $t=\frac{1}{4a^3}\left[\log\frac{a+\theta}{a-\theta}+\frac{1}{i}\log\frac{a+\theta i}{a-\theta i}\right]+c$

$$\therefore\ 4a^3(t-c)=\log\frac{a+\theta}{a-\theta}-\log\left(\frac{a+\theta i}{a-\theta i}\right)^i$$

$$=\log\left(\frac{a+\theta}{a-\theta}\right)\left(\frac{a-\theta i}{a+\theta i}\right)^i$$

$$\therefore\ e^{4a^3(t-c)}=\left(\frac{a+\theta}{a-\theta}\right)\left(\frac{a-\theta i}{a+\theta i}\right)^i.$$

NOTE.—From this last equation we see that $\left(\frac{a-\theta i}{a+\theta i}\right)^i$ is a real quantity.

CREDIT FOR SOLUTIONS RECEIVED.

Algebra 178. E. M. Venables. (1)
Algebra 179. E. M. Venables. (1)
Geometry 181. E. M. Venables. (1)
Algebra 184. W. G. Baab, J. A. Hardin. (2)
Geometry 186. Norman Anning. (1)
Trigonometry 188. J. A. Hardin. (1)
Algebra 190. Norman Anning, Walter L. Brown (2 solutions), I. L. Winckler, G. B. M. Zerr. (5)
Algebra 191. Walter L. Brown, H. L. McAlister, Orville Price, O. R. Sheldon, H. E. Trefethen, O. D. Tyner, I. L. Winckler, G. B. M. Zerr. (8)
Geometry 192. Wm. B. Borgers, R. Boyle, Walter L. Brown, G. A. Green, J. A. Hardin, H. L. McAlister, Chas. T. Moore, Orville Price, O. R. Sheldon, H. E. Trefethen, O. D. Tyner, J. A. Whitted, I. L. Winckler, G. B. M. Zerr. (14)
Geometry 193. W. T. Brewer, Walter L. Brown, J. A. Hardin, Chas. T. Moore, H. E. Trefethen, I. L. Winckler, G. B. M. Zerr. (7)
Applied Mathematics 194. Wm. B. Borgers, Walter L. Brown, Orville Price, H. E. Trefethen, J. A. Whitted, I. L. Winckler, G. B. M. Zerr, E. B. Escott. (8)
Total number of solutions, 49.

PROBLEMS FOR SOLUTION.

Algebra.

201. *Proposed by Franklin T. Jones, Cleveland, O.*

Find the value of $\frac{21 \times 143}{34}$, the numbers being written in the scale of seven. Perform the indicated multiplication and division in the scale of seven, then change the numbers to the scale of ten and verify your results. (From a Harvard examination in Advanced Algebra.)

202. *Proposed by H. E. Trefethen, Kent's Hill, Me.*

If $u > v > z$, show that $\left(\frac{u+z}{u-z}\right)^u < \left(\frac{v+z}{v-z}\right)^v$.

203. *Proposed by G. B. M. Zerr, Philadelphia, Pa.*

Extract square root of $1+12\sqrt{-3}-4\sqrt{-6}+6\sqrt{2}$.

Geometry.

204. *Proposed by Norman Anning, Chalfwick, B. C., Canada.*

Given, as centers, three points which form the vertices of an acute-angled triangle; describe three mutually orthogonal circles.

205. *Proposed by I. L. Winckler, Cleveland, O.*

From any point P in the bisector of the angle A in a triangle ABC, perpendiculars PA′, PB′, PC′ are drawn to the three sides. Prove PA′ and B′C′ intersect in the median from A.

Miscellaneous.

206. *Proposed by H. E. Trefethen, Kent's Hill, Me.*

A bullet fired with a velocity of 1000 feet per second penetrates a block of wood to a depth of 12 inches. If it were fired through a plank of the same wood, two inches thick, what would be its velocity on emergence, assuming the resistance of the wood to the bullet to be constant?

The Cobalt mines which objected to the royalty imposed as being too heavy have been granted a reduction, though not to the extent they hoped for, the announcement being made that the government has decided to reduce the royalty from 25 per cent on the gross output to 25 per cent on the net profit of the mines, which is to be ascertained under the provisions of the Supplementary Revenues Act.

The minute markings in a polished marble which obtain for it such names as "bird's-eye" or "madrepore" marble and the like are due to the remains of fossil corals or sea shells or sea lilies, called encrinites. The latter are the calcareous cases of fossil sea worms. The large colors and cloudings often resembling trees and landscape ferns are due to solutions of iron oxide entering the limestone when it was in the condition of soft mud. These impurities in the crystallization of the rock come out in vivid colors, red, green, gray, lavender, yellow, etc., and add greatly to the beauty of the stone when it is polished.

REAL APPLIED PROBLEMS IN ALGEBRA AND GEOMETRY.

COMMITTEE ON INVESTIGATION: JAMES F. MILLIS, *Chairman, Francis W. Parker School, Chicago;* JOS. V. COLLINS, *State Normal School, Stevens Point, Wis.;* C. I. PALMER, *Armour Institute of Technology, Chicago;* E. FISKE ALLEN, *Teachers College, New York, N. Y.;* A. A. DODD, *Manual Training High School, Kansas City, Mo.*

Teachers are invited to contribute problems to these columns, and to try out in the class room the problems that are here printed.

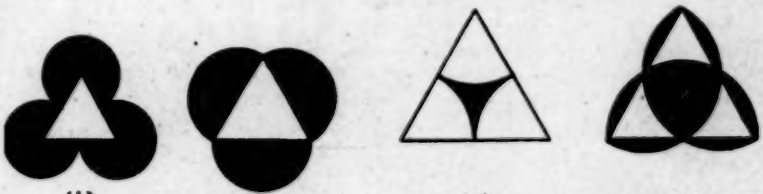
For the convenience of teachers who wish to use them, the problems printed in SCHOOL SCIENCE AND MATHEMATICS up to November, 1909, have been rearranged and grouped according to the parts of the subjects of which they are applications. They are bound in pamphlet form, so that a copy may be placed in the hands of each pupil. These pamphlets may be secured in any quantity, at 5c a copy, from the Secretary of the Mathematics Section, Miss Mabel Sykes, Bowen High School, Chicago, Ill.

PROBLEMS.

By William Betz, East High School, Rochester, N. Y.

The following exercises have been thoroughly tested in the schoolroom. They are simply samples of a large number of similar problems based upon either original or well-known designs that are encountered in architecture, etc. In most cases, the perimeters or areas, or both, are required. Many additional questions might be based upon these figures. The dimensions are either numerical or—preferably—literal.

1. In the trefoil in Fig. (1), the side of the equilateral triangle



is $2a$. Find the perimeter of the figure formed by the arcs of the circles, and the area of the whole figure enclosed by the arcs.

NOTE.—Pupils enjoy constructing these figures accurately. The different parts of the figures may be colored with different colored inks or pencils. Thus, in Fig. (1), the triangle may be made black and the circular sectors red. It is found that high school pupils enjoy this coloring very much.

2. In the trefoil in Fig. (2), the side of the equilateral triangle is $2a$. Compute the perimeter and the area of the whole figure enclosed by the arcs.

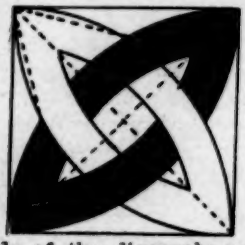
3. In Fig. (3), the side of the equilateral triangle is $2a$. Compute the perimeter and area of the shaded portion enclosed by the arcs.

4. In Fig. (4), the side of the equilateral triangle is $2a$. The middle points are the centers used in drawing the arcs. Compute the perimeter and area of the figure enclosed by the arcs.

Compute the area of the portion of the figure lying outside of the triangle and within the arcs.

Compute the perimeter and area of the shaded portion within the triangle.

5. Construct a square with a side $2a$. At two adjacent vertices construct angles of 30° with the diagonals. With the vertices as centers,

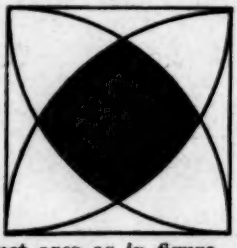


draw arcs from the ends of the diagonals and also from the points where the sides of the 30° angles cut the diagonals.

Find the perimeter of the lens-shaped bands. Also find the area of the bands, ignoring the portions where the bands overlap.

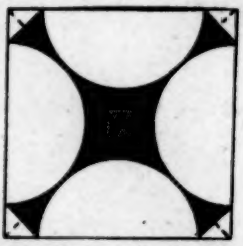
Make the same computations when the diagonal of the square is $2a$.

6. Construct a square with a side $2a$. With the vertices as centers,

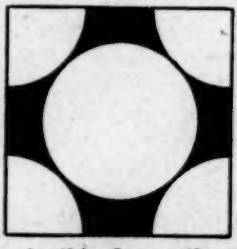


and $2a$ as radius, construct arcs as in figure. Find the perimeter and area of the shaded portion bounded by the arcs.

7. In the design shown in this figure, the side of the square is $2a$.



The inscribed semicircles are tangent to the diagonals. Find the perimeter and area of the shaded portion of the figure.



8. In the design shown in this figure, the side of the square is $2a$.

The radius of each arc is one-fourth of the diagonal of the square. Find the perimeter and area of the shaded portion lying between the circles.

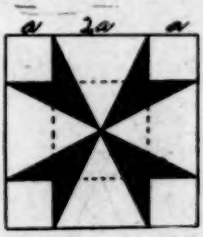
9. The sides of this rectangle are a and $2a$. Find the area of the

shaded portion of the design.

10. In this design the dimensions are shown in the drawing. Find

the area of the bands, including but once the portions where the bands cross.

11. In this design, the side of the square upon which it is constructed



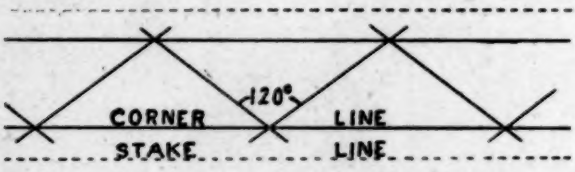
is $4a$. Find the area of the shaded portion.

12. Show how to construct the design shown in this figure.

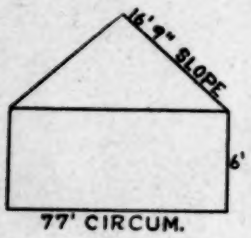
(The computation of the area requires the use of trigonometry.)

By John H. Bortz, High School, Greensburg, Pa.

13. The figure shows a ground plan of a zigzag or "worm" fence.



The rails are eleven feet long, and a lap of 1 ft. is allowed at each corner. Stakes, supporting the rider rails, are set 18 in. from each corner. Find the amount of waste ground by the construction of such a fence 100 rods long.



By Wm. O. Beal, Illinois College, Jacksonville, Ill.

14. (Furnished by an attorney.) A man wished to find the number of tons of hay in the stack shown in the diagram, allowing 512 cubic feet to the ton. Compute it.

The discovery of several seams of coal, a few inches to 7 ft. in thickness, in the sedimentary strata of a mountain in the Antarctic region, and of fossil remains of conifer trees by Lieutenant Shackleton's recent expedition, is a very remarkable one, and is analagous to similar discoveries of coal accompanied by fossil imprints of semi-tropical or temperate-zone foliage within the northern Arctic Circle, and in such high altitudes as those of Spitzbergen and northern Alaska, both the coal and the fossil foliage go to show that a very different climate than now, once prevailed in those regions—a climate comparable to that of Europe and the middle and southern states of North America, or even warmer. To account for such warm conditions is as difficult as to account for the present great ice-cap at the poles, and that of the glacial epoch, whether we assume a geological or an astronomical cause of these strange phenomena, such as local subsidence and elevation of land at the poles, or that the axes of the earth have changed places with regard to their position and distance from the sun and its heat.

SCIENCE QUESTIONS.

FRANKLIN T. JONES,

University School, Cleveland, Ohio.

Readers of SCHOOL SCIENCE *are invited to propose questions for solution—scientific or pedagogical—and to answer the questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.*

Questions and Problems for Solution.

21. *From an examination paper of the International Y. M. C. A.*

A grocer has a platform balance the ratio of whose arms is 9 to 10. If he sells 20 pounds of merchandise to one man, weighing it on the right hand pan, and 20 pounds to another man, weighing it on the left hand pan, what per cent does he gain or lose by the two transactions?

22. *From an examination paper of East High School, Cleveland.*

A and B carry a fish weighing 54 lb. slung between them from the middle of a ten-foot oar. One end of the oar rests on A's shoulder, but the other end is pushed one foot beyond B's shoulder. What part of the weight does each carry?

23. *From an examination paper of East High School, Minneapolis.*

How much heat will a 16-candle power light give out in one hour?

24. *From an examination paper of the University of Oxford.*

A half-ounce bullet is fired with a velocity of 1,400 feet per second from a gun weighing 7 lb. Find the velocity in feet per second with which the gun begins to recoil, and the mean force in pounds weight that must be exerted to bring it to rest in four inches.

Solutions and Answers.

18. *From an examination paper of the High School, Montclair, N. J.*

Using a meter stick (weight = 140 gm.) a boy finds the weight of a trout to be 1,260 gm. by suspending the fish from one end of the stick and balancing it on the edge of a knife blade. Find at what point the blade must be placed.

Solution by G. B. M. Zerr, Philadelphia.

Consider the weight of the stick as concentrated at its mid-point, and let x = the distance the blade is placed from the end (in centimeters). Taking moments about this point we easily get—

$$1260\,x = 140\,(50 - x)$$
$$1260\,x = 7000 - 140\,x$$
$$1400\,x = 7000$$
$$x = 5 \text{ centimeters.}$$

COMMON SENSE IN TEACHING.

In the March number of SCHOOL SCIENCE AND MATHEMATICS I note the statement that "by common consent the necessary preparation for the high school teacher will include university or collegiate training in his specialty." Such statements, of course, are always made by university and college men, but after some familiarity with the teaching of these pupils of the college and university I am not quite ready to be included with those who give common consent to this proposition. In taking such a stand I have no desire to intimate that a graduate of a college or university cannot successfully teach his subject in the high school, for some people are endowed with horse sense to start with, but that the mere spending of four years at a "higher institution of learning" will equip anybody for teaching is a belief that we should hasten to root out of our minds. Some of the biggest fizzles as teachers that it has been my fortune to know had diplomas from well-known universities locked up in their trunks.

The college man is wont to complain that the high school teacher is inclined to teach the college frog, forgetting that the teacher has only studied the college frog, that he teaches from a book made by the person in charge of the college frog, and that high school pupils are supposed to be taught to the end that they may in time go away to an institution where they may help dissect the college frog. What else could one expect? Why continue to complain that high school courses are but dilute college courses when such courses are all that the young teacher knows anything about? It is not to be expected that either college or university will teach the sciences solely, or even primarily, with regard to their value to teachers; therefore it is difficult for one to see why university preparation should be insisted upon. Possibly the employment of college methods in the high school is responsible for a large amount of the complaint heard nowadays that the high school is out of joint with the times.

By the very nature of the case, science courses in college are special courses, while similar courses in the high school are general courses, dealing with fundamentals only. A man may study plant ecology in college, but he has no business teaching a high school course in ecology; he may perform hundreds of experiments dealing with the physiology of plants, but he deserves to fail if he tries the same thing in the high school. The high school pupil wants only the fundamentals, and a good course should be blended of the various important things in anatomy, physiology, morphology, ecology, and classification. Undoubtedly the reason so many botanical courses run to seed and waste the time of the students in "analyzing flowers" is because the young teacher has not the slightest idea how to go about teaching real botany.

The successful high school teacher must be a person of exceptional ability, for he must not only be able to communicate his own knowledge to mere children, but must frequently translate the college-made texts into childish terms of thought. It is thus quite conceivable that

a person with an aptitude for scientific things, who has had a thorough training in a good high school, should after four years of teaching be a much better teacher than one who has spent four years in college; and I am not prepared to say that he will not always remain so. For be it known that a headful of special knowledge is not half so important in a teacher as the ability to impart knowledge and stimulate enthusiasm coupled with the good sense to perceive any lack of essentials and the ability to make that lack good by study. It is well known that many college graduates who become teachers act as if their diploma was a license to stop thinking. Even a college-bred man soon ceases to be worth much as a teacher if he does not keep pace with the advances in his specialty. The high school teacher must know his subject, but it makes no difference whether he acquired his knowledge in the university or got it by continuing the studies begun as a pupil in high school. And if we admit to our discussion the really great teachers of the world we find that many of them are of this latter class. Especially is this true of science. Many of our scientists have not been college men. Let me repeat, I do not in the least wish to minimize the value of college training, but rather to emphasize the fact that college training is not all nor even a very large part of a successful teacher's equipment. The one thing we should ask of him is not "Have you been through college?" but "Can you deliver the goods?"

WILLARD N. CLUTE.

THIRD ANNUAL MEETING OF THE ILLINOIS STATE ACADEMY OF SCIENCE.

In attendance, number, and character of papers presented, and in the general spirit of enthusiasm and interest, the meeting at Urbana, February 18 and 19, is regarded with great satisfaction by those who had the good fortune to be present.

More than one hundred new members were elected so that now the Academy, while but three years old, has something more than four hundred names enrolled on its list—a fact which speaks well both for the enthusiasm and the spirit of helpfulness of Illinois men of science, thus repudiating the idea that men of science are recluses. About one hundred and fifty people were present at the various meetings.

After a short business meeting, Friday, 2 P. M., the following program was presented: "Dr. A. W. French, In Memoriam," A. R. Crook, five minutes; "A Needed Piece of Work in the Interest of our Young Investigators in Biology," T. W. Galloway, ten minutes; "The Vegetational History of a Blowout," H. A. Gleason (lantern), ten minutes; "Recent Habitat Changes in the Illinois River," Chas. C. Adams (lantern), fifteen minutes; "Forest Successions on Isle Royale," Wm. S. Cooper (lantern), twenty minutes; "An Ecological Study of the Fish of a Small Stream," Thomas L. Hankinson.

8 P. M.: Address of Welcome by the President of the University of Illinois; Presidential Address, "Relations of the Illinois Academy of

Science to the State," Stephen A. Forbes; "Informal Account of my Recent Oriental Trip," T. C. Chamberlin; Reception given by the Illinois Chapter of Sigma Xi.

Saturday, 9 A. M., Symposium (fifteen minute talks) "The Relation of Pure and Applied Science to the Progress of Knowledge and to Practical Affairs"; "In Biology," Cornelius Betten, Lake Forest College; "In Chemistry," Julius Stieglitz, University of Chicago; "In Physics," John T. Hayford, Northwestern University; "The Relation of Pure and Applied Science to Secondary Education," C. G. Hopkins, University of Illinois; Worrallo Whitney, South Chicago High School.

11 A. M., Presentation of Papers: "The Passing of Our Game Birds," Isaac E. Hess, ten minutes; "Further Studies on the Influence of Copious Water-Drinking with Meals," P. B. Hawk, ten minutes; "Biology and Other Sciences as Applied by a Breeder," Q. I. Simpson, fifteen minutes.

2 P. M., Presentation of Papers: "Report on the Ecology of the Skokie Marsh Area near Chicago, with Special Reference to Its Mollusca," Frank C. Baker (lantern), ten minutes; "Ecological Succession of Fish and Its Bearing on Fish Culture," V. E. Shelford (lantern), fifteen minutes; "Forest Associations of Northwestern Illinois," H. S. Pepoon, fifteen minutes; "Relic Dunes," Frank C. Gates (lantern), five minutes; "On the Relation of the Jeffersonville Beds of Indiana to the Grand Tower (Onondago) Limestone of Illinois," T. E. Savage, fifteen minutes; "Observations on the Earthquake in the Upper Mississippi Valley, May 26, 1909," Johan August Udden, twenty minutes.

Officers for the ensuing year are: President, John M. Coulter, University of Chicago; Vice-President, R. O. Graham, Illinois Wesleyan University; Secretary, A. R. Crook, State Museum Natural History; Treasurer, J. C. Hessler, James Millikin University.

Third Member Publication Committee, H. H. Stoek, University of Illinois.

Membership Committee: Fred L. Charles, University of Illinois; Thomas L. Hankinson, Eastern Illinois State Normal; V. E. Shelford, University of Chicago; W. E. Tower, Englewood High School; Isabel Seymour Smith, Illinois College.

Committee on Ecological Survey: Stephen A. Forbes, V. E. Shelford, H. A. Gleason, E. N. Transeau, Frank C. Baker, Charles C. Adams.

Committee on Deep Drilling: J. A. Udden, U. S. Grant, Frank DeWolf.

Committee on Assistance of the Academy to High School in Science Teaching: C. J. Hopkins, John F. Hayford, John G. Coulter, Worrallo Whitney, W. S. Strode.

Committee to Influence Legislation in favor of increased protection for Game Birds: Stephen A. Forbes, John M. Coulter, A. R. Crook, J. C. Hessler.

Committee to Influence Legislation to Restrict the Collection of Birds and Eggs Solely to Accredited Institutions: F. C. Baker, I. E. Hess, F. L. Charles.

Committee to Coöperate with Existing Agencies for Advancement of Nature Study in Elementary Schools to be announced later.

A. R. CROOK, Secretary.

INTERNATIONAL COMMISSION.

THE PRESENT STATUS OF THE MEMBERSHIP IN THE INTERNATIONAL COMMISSION ON THE TEACHING OF MATHEMATICS IS AS FOLLOWS:

I. PARTICIPATING COUNTRIES.

AUSTRIA.—E. Czuber, Hofrat, Professor in the Vienna School of Technology.
R. Suppantschitsch, Professor in the "Realschule," Vienna.
W. Wirtinger, Professor in the University of Vienna.

BELGIUM.—J. Neuberg, Professor in the University of Liège.

DENMARK.—P. Heegaard, Professor in the military school, Inspector for Mathematics in the "Lycées" of Denmark.

FRANCE.—A. de St. Germain, former Dean of the Faculty of Sciences of the University of Caen, chairman;
C. Bourlet, Professor in the Conservatory of Arts and Handicrafts and in the School of the Fine Arts, Paris;
C. A. Laisant, Examiner for the Polytechnic School, Paris.

GERMANY.—F. Klein, Geheimer Regierungsrat, Professor in the University of Göttingen.
P. Staeckel, Geheimer Hofrat, Professor in the School of Technology at Carlsruhe;
P. Treutlein, Principal of the "Real and Reform Gymnasium," Carlsruhe.

GREAT BRITAIN.—Sir George Greenhill, F.R.S., formerly Professor in Woolwich College, London;
C. Godfrey, Professor in the Royal Naval College, Osborne.

GREECE.—C. Stephanos, Professor in the University of Athens.

HOLLAND.—J. Cardinaal, Professor in the School of Technology at Delft.

HUNGARY.—M. Beke, Professor in the University of Budapest;
G. Rados, Professor in the School of Technology at Budapest;
Ratz, Professor in the "Gymnasium" at Budapest.

ITALY.—G. Castelnuovo, Professor in the University of Rome;
F. Enriquez, Professor in the University of Bologna;
G. Scorza, Professor in the School of Technology at Palermo.

NORWAY.—M. Alfsen, Professor in the "Lycée" Christiania, member for mathematics of the Council of Public Instruction.

PORTUGAL.—G. Teixeira, President of the Polytechnic School at Porto.

ROUMANIA.—G. Tzitzeica, Professor in the University of Bucharest.

RUSSIA.—N. v. Sonin, President of the Ministry of Public Instruction, St. Petersburg;
Kojalovic, Professor in the School of Technology at St. Petersburg;
K. W. Vogt, Principal of the Second "École Réale" at St. Petersburg.

SPAIN.—Z. G. de Galdeano, Professor in the University of Saragossa.

SWEDEN.—H. von Koch, Professor in the School of Technology at Stockholm.

SWITZERLAND.—H. Fehr, Professor in the University of Geneva, Chairman;

C. F. Geiser, Professor in the Polytechnic School at Zurich;
J. H. Graf, Professor in the University of Bern.

UNITED STATES.—David Eugene Smith, Professor in Columbia University, chairman;
W. F. Osgood, Professor in Harvard University;
J. W. A. Young, Professor in the University of Chicago.

II. ASSOCIATE COUNTRIES.

CANADA.—Bovey, Rector of the Imperial Technical College at London.

CAPE COLONY.—S. S. Hough, Astronomer at the Royal Observatory in Cape Town.

JAPAN.—Fujesawa, Professor in the University of Tokio.

MEXICO.—V. Gama, Subdirector of the Observatory of Tacuyaba, Professor in the National School for Engineers.

METROLOGICAL NOTES.

Proposed New Calendar. A San Francisco firm issues a calendar of thirteen months per year, proposed to take the place of the present twelve months' calendar. The author of this idea divides the year into thirteen months of four weeks, or twenty-eight days each, making 364 days. Every month is to begin on Sunday and end on Saturday. Any given day of any week would then fall on one of four dates; for example Wednesday would in each month come on the fourth, eleventh, eighteenth, or twenty-fifth, thus avoiding all calculations made necessary by our present calendar.

The additional month is named "Vincent" and put between June and July. The three hundred and sixty-fifth day will fall between December 28 and January 1, and it is proposed to call this "Anno Day." Worw done on Anno Day would be by special contract, and no interest or rent would accrue on that day. For leap year an extra day is to be added, known as "Mid-Anno Day" and placed between Vincent 14 and 15, and treated like Anno Day.

The most important beds of phosphate rock are those of Florida, more than three-fifths of the total tonnage for the United States being produced in that state, with a value nearly two-thirds that of the total production for the country. The phosphate rock of Florida is divided by Eldridge into hard rock, containing about 36.65 per cent phosphoric anhydride, corresponding to 80 per cent phosphate of lime; soft rock, usually averaging less than 22 per cent phosphoric anhydride, 50 per cent phosphate of lime; land pebble, averaging 32 per cent phosphoric anhydride, 70 per cent phosphate of lime; and river pebble, averaging 20 per cent phosphate anhydride, or 45 per cent phosphate of lime for the Black Creek deposits, and 28.40 per cent, 61 per cent phosphate of lime, for the Peace river beds.

THE AMERICAN FEDERATION OF THE TEACHERS OF THE MATHEMATICAL AND NATURAL SCIENCES.

The annual meeting of the Council of the American Federation was held on Monday, December 27, 1909, at the Massachussetts Institute of Technology in Boston, Mass. There were twenty-two representatives of eight associations present. The report of the Executive Committee showed that six associations had joined the Federation during the past year. The total number of paid up members in the associations that belong to the Federation now amounts to 2,040.

Reports were presented from the local associations showing activity and progressive work in all. These reports are appended.

The committee on bibliography of science teaching reported that its work was completed and urged the Federation to get the bibliography printed as soon as possible.

The committee on a syllabus in geometry reported that work was well under way. The committee has been divided into three subcommittees, one on logical considerations, one on lists of basal theorems, and one on exercises and applications. The committee expects to have its work completed during the coming year. The report follows.

The committee on college entrance requirements had gathered a large amount of information which showed the great variation in the requirements of the different colleges and showed that it was impossible for any school to meet them all. The committee recommended that the Federation take up this matter with the College Entrance Examination Board and see what can be done toward bringing about uniformity. The report was accepted as a report of progress and the committee continued and urged to carry on the work.

The committee on publication recommended that the Federation publish its reports in SCHOOL SCIENCE AND MATHEMATICS and such other journals as would accept them and urged that the local associations send their reports of their meetings to SCHOOL SCIENCE AND MATHEMATICS promptly and regularly. The report was accepted as a report of progress and the committee continued.

The New England Association of Chemistry Teachers presented a request that the Federation appoint a committee to make suggestions for changes in the definition of the requirement in chemistry and that the Federation should bring this matter to the attention of the College Entrance Examination Board. The request was approved.

A letter from the College Entrance Examination Board asked coöperation of the Federation in determining what form of logarithm tables were best study for examination purposes. It was voted that a committee be appointed by the chair in accordance with the wishes of the College Board.

The question of the publication of a journal for mathematics alone was discussed at some length and it was voted that a committee be appointed to consider this question and report at the next meeting.

Informal reports of progress were presented by members of the International Commission on Teaching of Mathematics.

The nominating committee reported nominations for officers for the coming year: President, C. R. Mann, University of Chicago; Secretary-Treasurer, Eugene R. Smith, Brooklyn Polytechnic Institute; Members of the Executive Committee, J. T. Rorer, Wm. Penn High School, Philadelphia; W. Segerblom, Phillips Exeter Academy; F. N. Mitchell, State Normal School, Milwaukee, Wis. These officers were unanimously elected.

Professor C. H. Judd of the University of Chicago addressed the Federation on the topic, "Scientific Experimental Investigation of Education." The speaker indicated that opinions concerning education were usually based upon rather vague and uncertain data. He urged that problems in education were capable of solution by scientific experiment and that they should be solved in that way. Several experiments were presented as types which might be followed.

Mr. H. R. Linville of Jamaica, New York, presented an address on "Old and New Ideals in Biology."

The meeting adjourned subject to the call of the Executive Committee.

REPORTS PRESENTED TO THE COUNCIL OF THE FEDERATION.

Report of the Executive Committee for 1909.

The following report of the Executive Committee covers the work of the Federation since the annual meeting in Baltimore in December, 1908. At the Baltimore meeting—as already announced—the Council authorized the collection of a larger assessment, at the rate of ten cents per member, also the appointment of committees on College Entrance Requirements, on a Geometry Syllabus, and on Publications and Publicity.

In regard to the increased assessment, it seemed to the Executive Committee wiser, after mature consideration, not to exercise the authority given it, particularly as the work immediately before it could be accomplished with funds available. The Committee has therefore confined itself to an announcement to the federated associations that such an increase might be anticipated in the near future. Nearly all the associations have assented to the increase, and the Executive Committee hereby recommends that the advance to ten cents per member be adopted by the Council.

The three committees above named were appointed by the Executive Committee after a careful study of the field, and after inviting nominations from each of the federated societies for membership in the Committee on College Entrance Requirements. The membership of these committees was announced in Bulletin 2, issued in November and sent to each member of each federated society. The chairman of each committee has been requested to plan the work of his committee on an economical basis, but it is already evident that the work of one at least of the committees will be hampered unless larger financial provision can be made, and, in any case, the publication of reports will be a source of expense.

The Council adopted at Baltimore a resolution favoring a liberal Congressional policy in regard to the Bureau of Education, and requesting the Executive Committee to take such steps as might be feasible toward giving effect to this resolution. No occasion for such action has yet presented itself.

The chairman of this Committee has been invited to act as a member of the Advisory Committee for the United States in connection with the work of the International Commission on the Teaching of Mathematics.

In connection with the definitions of College Entrance Requirements, the chairman has also been in communication with the officers of the College Entrance Examination Board having to do particularly with matters of definition.

The second annual Bulletin of the Federation, issued in November, contains a full account of the Baltimore meeting, and announcements for the Boston meeting. Both issues of the Bulletin have been somewhat widely circulated, not merely to members of the federated associations, but to educational periodicals in this country and in Europe, and have elicited interesting correspondence abroad and at home.

During the year the following associations have joined the Federation: the Association of Ohio Teachers of Mathematics and Science, the Colorado Mathematical Society, the New York State Science Teachers Association, the Iowa Association of Science Teachers, South Dakota Association of Science and Mathematics Teachers.

On behalf of the Association of Mathematical Teachers in New England, Mr. G. W. Evans reported that this association contains some two hundred and seventy-five members, and the meetings of the past year have been fully attended and of considerable interest. The subjects considered during our meetings have been successively: "The Treatment of Locus Problems in Geometry," "The Nature of a Ratio," "Certain Modern Suggestions in the Detail of Arithmetic Teaching," and "Certain Recent Changes in the Modern Teaching of Geometry." Reports of these papers will appear in SCHOOL SCIENCE AND MATHEMATICS, beginning with December, 1909.

The midwinter meeting for the year was omitted because of a misunderstanding in regard to the place where the meeting was to be held. This meeting is usually held in New England, at a place remote from Boston. Sometimes speakers from the main Association take part, and sometimes speakers from the local section carry the burden of the day. It is hoped that this midwinter meeting will hereafter be a permanent feature of the annual work of the Association.

Mr. Eugene R. Smith, on behalf of the Association of Teachers of Mathematics in the Middle States and Maryland, reports that the year 1909 has been one of decided advance to this Association: the association and its sections have held a number of meetings at which excellent papers have been read, and at which the body of the Association has shown its interest by spirited discussions.

Probably the greatest advance has been in the line of our publication. Instead of publishing simply an annual report, the Association now publishes a quarterly magazine for teachers of mathematics, called "The Mathematics Teacher." This quarterly was started early in 1909, and four numbers were published for the school year 1908-9, and two numbers have been published for the current year. Under the able editorship of Dr. W. H. Metzler, it has already taken an important place among teachers' periodicals. Subscriptions have been sent even from Europe and from Africa, and the prevailing feeling is that the magazine is now well established.

Two important committees have reported during the year: the New York Section committee on marking Mathematical papers, and the Algebra Syllabus committee. The marking committee made a very comprehensive report which was published in *The Mathematics Teacher*. This report has been favorably reported upon by the Regents Office at Albany, and it seems likely to be quite widely adopted as a standard for marking. Copies of this report are on sale by the secretary of the New York Section.

The Algebra Syllabus committee made its preliminary report on elementary and intermediate Algebra. With slight amendments, the report was adopted by the Association. It is expected that this report, in final form, and with the addition of advanced Algebra, will be published in shape for use this following spring. The report has been highly approved by some of the best known educators in our territory.

The Association has other committees at work, and is taking an active part in all those activities that tend toward the improvement of the profession. Its membership is over five hundred, and its finances are in excellent condition, in fact, it now appears to be equipped to wield a stronger influence than ever before.

The report of the Physics Club of New York was presented by Mr. F. B. Spaulding as follows:

The Physics Club of New York reports a successful year's work. Our membership is now about eighty, several of the more recent additions being ladies. Our membership is strictly confined to teachers of physics in secondary schools, and our interests are almost purely pedagogical.

The meetings thus far this season, arranged by Pres. Willard R. Pyle, have been of unusual interest. At our last meeting, Prof. Karl Runge of the University of Goettingen presented a paper on the problem of aerial navigation which will appear in SCHOOL SCIENCE AND MATHEMATICS in the near future.

In New York, as in Boston, departmental lines are closely drawn professional organizations. We have the Physics Club, the Chemistry Teachers' Club, the Biology Teachers' Club, while the mathematics teachers are organized under the Middle States Association of Mathematics teachers.

The report of the Central Association of Science and Mathematics Teachers was presented by Mr. C. H. Smith, as follows:

The Central Association of Science and Mathematics Teachers during 1909 increased its paid-up membership from 328 to 449, an increase of 40%. This increase was distributed evenly between the local centers affiliated with the Central Association and the parent body and represents a healthy growth that may reasonably be expected to continue as the growth in the extent of its territory continues. During the year the Arkansas Association affiliated and the North Eastern Ohio took similar action.

The publication of the complete Proceedings of the 1908 meeting in the spring put into effect a policy that had been contemplated for some time and which is now a part of the regular work of the Association. This publication not only preserves in permanent form the papers, addresses, and reports presented at the Annual Meeting, but gives to the members not in attendance the complete account of the sessions.

This publication further makes possible and desirable the membership in the Association of institutions, such as libraries and colleges, steps to secure which are already under way. The 1908 Proceedings is of especial value to teachers of Mathematics as it contains the complete reports of committees that have been at work for years upon Geometry, Algebra, and Unifying Mathematics.

Its papers upon the fundamental principles of Biology, Earth Science, Chemistry, and Physics represent the most progressive thought in the country.

At the Annual Meeting in 1909 the proposition to take up the scientific study of education gives promise to yield excellent results in the next two years.

The New York Association of Biology Teachers reported the following as the general plan of the work of the Association for year 1909:

(1) The Function of First Year Biologic Science in the City High School. Discussed by the principals of several High Schools (Sullivan, Gumison, Lyman, Toule, Larkins, etc.)

(2) What is of Most Worth in the Course of Biology for the City Child? How may it be adapted to his needs? (Discussed by Board of Education officials—Dr. E. L. Stevens, Dr. Ward Crampton, Dr. Bigelow, and others.)

(3) The Relation of Nature Study to High School Biology. (Discussed by Mr. Gilbert Trafton and members of the Association.)

(4) The Relation of Biology to the other Sciences of the High School. (Talk by Prof. John H. Woodhull, Teachers College.)

(5) "The Relation of Biology of the High School to that of the College," by C. F. Hodge, Clark University.

In connection with this general program of work, some substantial committee work has been accomplished.

(1) The Association became a member of the Federation of Teachers' Associations.

(2) A committee acted in connection with the Museum of Natural History in affording lectures to High Schools on Economic Subjects. Result: 600 students were reached in each of five lectures.

(3) A committee to coöperate with the Medical Association for the advancement of the interests of Biology in the schools. The committee reported that 1,380 pupils in the High Schools of New York City had no instruction in Physiology and Hygiene whatever.

(4) A committee to coöperate with the American Society of Social and Moral Prophylaxis in the trying of an experiment in sex teaching. Dr. Eddy reported an experiment tried during one term with apparent success. In connection with this report an address was delivered before the Association by Dr. Prince A. Morrow, president of the Society, on "The Scientific Study of Sex Education—What is Planned and What has been Accomplished."

Mr. Wilhelm Segerblom presented the report of the New England Association of Chemistry Teachers as follows:

The thirty-third meeting of the Association was held at the Worcester Polytechnic Institute on November 14, 1908. At this meeting Professor Jennings delivered an address on "Alchemy, Past and Present." This address was illustrated by lantern slides and it was both interesting and instructive. Dr. McFarland's "Elementary Principles of Chemistry" was reviewed at the morning session. The advisability of teaching in a first year course the theory of electrolytic dissociation, the mass law, osmotic pressure, and the determination of molecular weights was discussed and many differences of opinion were brought out.

The morning session of the thirty-fourth meeting was held at Simmons College, February 13, 1909. Wilhelm Segerblom's "Qualitative Analysis" was reviewed at this meeting. Mr. Peterson spoke in appreciation of the work of Mr. Edward F. Holden. Professor Norris spoke on recent advances in chemical conceptions of valence. Prof. Henry P. Talbot's address brought clearly to mind the difficulties involved in the teaching of chemistry. The Association is deeply indebted to Professor Talbot for the very careful review of the relations existing between the colleges and the secondary schools. At the afternoon session Professor Frank H. Thorp gave an illustrated lecture on "Destructive Distillation." This lecture was one of the lectures of the Saturday course on Industrial Chemistry.

The thirty-fifth meeting was held at Boston University on May 8, 1909. Prof. Louis Derr gave a very interesting account of the development of the Photographic Image. Mr. Arthur A. Blanchard spoke on the "Passive State of Metals." Prof. Lyman C. Newell in his "Chemical Pilgrimage" gave material of the greatest value. Rare books and portraits were shown by Prof. Newell and the opportunity of seeing these was an unusual one.

Through the kindness of Prof. A. Lawrence Lowell, a course on Industrial Chemistry was given free of charge to the members of the Association. Prof. Frank H. Thorp conducted this course and through his conscientious work those taking the course were supplied with a wealth of material on the subject of Industrial Chemistry.

This year a course has been arranged on the Chemistry of Food. Prof. A. G. Woodman is to conduct the course and two of the fifteen lectures were given during November. At the present time sixty-nine people are taking the course under Professor Woodman.

The membership of the association is at present: honorary, 17; active, 73; associate, 100, making a total of 190 members. This same number was reported last year at the annual meeting. Fourteen members have resigned during the year and one of the active members has asked to be changed to an associate member.

Every attempt has been made to publish reports of the meetings in full for the benefit of those who are unable to be present. It is earnestly desired that all teachers of chemistry in the vicinity of Boston become active members and take an active part in pushing forward the work of the Association.

At the last meeting of the New England Association of Chemistry Teachers held in December, 1909, it was voted that the Association request the American Federation of the Teachers of the Mathematical and Natural Sciences to petition the College Entrance Examination Board to revise the chemistry syllabus. Our secretary has communicated with the secretary of the American Federation regarding the matter.

The following letter from the President of the Missouri Society was presented: I beg to report for the Missouri Society of Teachers of Mathematics and Science that the Society has been prosperous during the past year. We held our annual meeting at the State University at Columbia in May, where there was an interesting joint meeting of the two sections, mathematics and science.

This was followed by separate meetings of the two sections, in which a number of interesting papers were presented. Officers were elected for the ensuing year, and all felt that the meeting had been helpful.

During the present holidays, the State Teachers' Association holds its meetings at St. Louis, and we have, *ex officio*, charge of the programs of the science and mathematics sections. Much labor has been expended on these, in the hope of making them as interesting and as helpful as possible to the members.

Some important work has been carried on by the president, as regards the policy of the society toward college entrance requirements, but except in physics, where the "unit" has been defined by a committee of secondary school teachers, matters have not advanced far enough to make a report advisable as yet.

The Iowa Association sent in the following report: The Iowa Association of Science Teachers meets annually in connection with the Iowa State Teachers' Association early in November. The section meetings are held on the first day of the meeting and the general session on the second. It is the aim to make the program of the section meetings quite informal, dealing with the vital problems met with in the teaching of secondary school science especially, though college men take an active part in the meetings. Each section has a leader who is responsible for the program and for the report of the meeting. The section leaders with the officers constitute the executive committee. The Association plans during the coming year to push a campaign of education among the school authorities of the state looking toward the selection

of teachers of science who have especially fitted themselves for this work and also to bring to the attention of school boards the absolute necessity for adequate equipment if satisfactory or creditable work is to be done. In both of these respects, Iowa is not in the front rank.

The Association also proposes through the section leaders to investigate the work done in each subject as a preliminary step toward securing greater uniformity and raising the standard.

The officers of the Association are as follows: Geo. W. Tidd, Ft. Dodge, Pres.; Prof. L. Begeman, Cedar Falls, Vice-President; F. E. Goodell, Des Moines, Sec.-Treas. Section Leaders: Prof. D. W. Morehouse, Des Moines, Physics; S. L. Thomas, Council Bluffs, Chemistry; Prof. R. B. Wylie, Iowa City, Biology; Zulema Kostomlatsky, Des Moines, Physiography. Delegate to American Federation: F. E. Goodell, Des Moines.

The report of the Colorado Mathematical Society was presented by Mr. G. B. Halsted as follows: The society was organized in 1905 and had held six meetings each year. The membership of the society had grown from twenty-five to forty-five. Topics for discussion during the past year have been, The Treatment of Irrational Numbers, in ninth grade Algebra. What should be omitted from the ninth grade algebra course. A popular account of the fourth dimension. All of the meetings have been pleasant and profitable and each subject proposed had led to a lively discussion. The importance of studying the pupils as they are and not expecting them to master what an adult considers a complete course was prominent in the discussion. "The general impression is abroad that mathematics is of little practical value, and that the result has been its neglect and consequent loss of mathematical power on the part of the pupil. Our civilization craves action, and a subject that loses contact with life is doomed."

REPORT OF THE COMMITTEE ON PUBLICATIONS.

In appointing this committee, President Tyler stated its object as follows: "To investigate the present general situation in regard to special publications on the teaching of science and mathematics, particularly periodicals and proceedings, and to recommend to the council any steps which may be appropriate to improve this situation: also to secure the publication of suitable material in newspapers and in periodicals of a general character."

Your committee was unable to meet until yesterday and two of the five members were then absent,* but a considerable amount of work has been done by correspondence.

The problem is by no means a simple one. A few of the affiliated societies publish practically nothing in any way. About half have a definite arrangement for publication of their reports in SCHOOL SCIENCE AND MATHEMATICS; and in addition to this several, like the two New England associations, the New York State Science Teachers' Association, and the Central Association print voluminous reports for distribution to their members. In the case of the Association of Mathematics

Teachers in the Middle States and Maryland, these reports have grown into a quarterly periodical, and a committee of the association is now working upon plans for further enlarging its scope.

The general situation is far from satisfactory. It is unfortunate that so much expense should be put into the publication of material for such limited circulation.

After consultation with representatives of several associations and with the publishers of the periodicals mentioned, your committee can offer no immediate solution of the problem, but offer the following recommendations:

1. That the Federation publish in SCHOOL SCIENCE AND MATHEMATICS and in such other journals as may accept them, full reports of its proceedings.

2. That the affiliated societies be requested to send to SCHOOL SCIENCE AND MATHEMATICS, and to such other journals as may accept them, full reports of all meetings with brief abstracts of all papers presented.

3. That each association be requested to appoint an editorial representative, if such has not already been designated, whose duty it shall be to prepare these reports and forward them for publication at the earliest possible date.

4. That the Executive Committee of the Federation endeavor to secure the coöperation of the National Bureau of Education in regard to publishing a yearly, annotated bibliography of science and mathematics teaching.

Frank B. Spaulding, Chairman; O. W. Caldwell, L. H. Newell, Evans, W. M. Gregory.

*Mr. Caldwell was represented by Prof. Mann. Mr. Evans was not at the meeting but approved the report before it was presented. Mr. Gregory was absent.

REPORT OF THE COMMITTEE ON COLLEGE ENTRANCE REQUIREMENTS.

The undersigned was appointed in the month of June last as Chairman of a Committee to outline a policy on the part of the Federation toward the present College Entrance Requirements in Mathematics and in Science.

The other members of the Committee were Messrs. R. B. Brownlee, New York, R. W. Buck, Dayton, W. A. Francis, Exeter, F. E. Goodell, Des Moines, E. C. Hallar, Kansas City, F. R. Hartwell, Syracuse, C. A. King, Brooklyn, Sydney Peterson, Boston, and J. T. Rorer, Philadelphia.

Before undertaking actual work, considerable correspondence was carried on with the various members, and it was finally decided that four sub-committees, each to consist of a single member, should be appointed to obtain such information as seemed to be needed prior to undertaking the suggestion of a line of action.

Accordingly the following plan was undertaken:

(1) Mr. F. E. Goodell was asked to ascertain from our leading colleges and universities what their actual requirements for admission were.

(2) Mr. Ralph W. Buck was asked to ascertain what the secondary schools are doing to meet the requirements of the colleges and universities.

(3) Mr. R. B. Brownlee was asked to ascertain whether the preparation of the secondary school is at present satisfactory to the colleges and universities.

(4) Mr. J. T. Rorer was asked to ascertain whether the present entrance requirements are satisfactory to the secondary schools.

All of these gentlemen have engaged in this important work with much interest, and have carried on an extensive correspondence and have filed with me the results, so that it now seems time that some definite statement should be made to the Federation of the situation, as it now stands.

The correspondence, etc., on which this report is based will be attached to the report for the information of the members of the Federation.

The policy, now recommended, has been submitted to the various members of the Committee by the Chairman, and has been freely endorsed as suitable by a majority of the members. From the nature of the case, it has not been possible to submit the final draft for approval, so that the Chairman must be responsible for the details, though the general policy has been approved, as just stated.

Correspondence develops the fact that there is a widely differing policy in regard to entrance requirements. Some colleges and universities receive students upon examination alone. Among the more important of these are Harvard, the Massachusetts Institute of Technology, Yale, Columbia, Princeton, Bryn Mawr, and the Case School of Applied Science. Others, and this includes almost all of the colleges and universities, except those just mentioned, receive students either upon examination, or on certificate from secondary schools, whose work and facilities have been examined and found to be satisfactory. These secondary schools are called "accredited," and their standing from time to time is reëxamined, to make sure that they are still worthy of consideration.

Furthermore, in these secondary schools there is much variation in regard to the means adopted for determining whether the student has completed the work for which he is lafer to be "credited." In some schools, as, for instance, in the high schools in St. Louis, students whose daily grades exceed eighty per cent, the student is excused from passing a "final" examination, and is passed on this evidence of work completed.

In such schools, and this plan is one very generally followed in the West, the student reaches the end of his four years' training with but a limited experience in the passing of formal tests. More attention by far has been given to the development of his powers of observation, reasoning, and expression, and less to the actual memorizing of the work over which he has passed.

In many of the excellent secondary schools of the East, in which preparation for college is in most cases the serious purpose alike of school and of student, constant practice is given the pupil in the passing of formal written tests. Thus it happens with the student of the Western school who presents himself for examination that he fails to do himself justice on account of his limited experience with formal tests, and the fact that he is really fully prepared to undertake serious work in the college or university is not apparent.

On the other hand, it sometimes occurs that the boy who has been specially prepared, with the view of passing a set test, covering the whole of the work of four years, passes, apparently, with much greater credit, since his memory has been much more thoroughly trained, and his personal experience is of such a kind as to ensure for the moment much better examination results.

So soon as the test of real work begins, the boy whose preparation has been carried out as is customary in Western schools speedily shows that his preparation has really been far more adequate than the results of the examination at first seemed to indicate.

Varying policies are followed by our colleges and universities in administering the entrance requirements in mathematics and science.

Amherst, for instance, accepts a certificate for elementary mathematics, and refuses to accept one for advanced mathematics. It is further prescribed that all work on which a certificate is offered must have been done or reviewed within the last two years of the course.

The University of Chicago, in defining the amount of work required in algebra, requires a unit (or year's work), which may be done at any point in the school course, and a half unit, which must not be given earlier than the third year. A certificate from an accredited school will be accepted for all of this work.

Cornell adds to her definitions of the mathematical units the statement not contained in other catalogues that it is not sufficient that the student should once have known his preparatory mathematics; he must know them at the time when he begins his work at college.

It would be easy to point out that there is a wide variation in regard to the nature of the requirements for admission to college, in mathematics. I have selected specific examples, in the belief that they would help to make the intolerable nature of the situation more apparent.

How is a secondary school to be able to fit its students to meet requirements, in which there is so much real and substantial difference?

In science, there is a lack of uniformity both in nominal requirements and in their actual application.

At Amherst, for instance, in physics, the requirement in physics simply calls for a year's work in some good text, with thirty-five experiments, and a properly prepared note book, to be presented for inspection when the student applies for admission.

Dartmouth demands at least forty experiments, and insists upon at least the equivalent of 110-hour exercises. The requirement in regard to the note book is somewhat similar to that for Amherst, except in the number of experiments.

Harvard specifies at least thirty-five experiments, chosen from a list of sixty, named by the university, with the further requirement of an actual laboratory examination.

Were it needed to reinforce the argument, ample illustration might be given of the great variations in college requirements and in their interpretations by those in charge of the administration of college entrance at various institutions.

The copy of the Report of Principal Stearns, of Phillips Exeter, to the New England Association of Schools and Colleges, which accompanies this report, is full of important suggestions. It appears from this report that some colleges, notably Cornell and Dartmouth, have totally different standards for admission in higher algebra—one for admission on certificate, another for admission by examination. The differences are so wide, as to require separate instruction for the two groups of boys going to the same college. Such a situation is preposterous, and should not be tolerated.

When one of the oldest and most successful of our Eastern schools finds the situation thus unbearable, is it not high time steps should be taken for a solution?

Since the first steps toward a change of existing conditions can only be taken by those who have so largely inspired and guided past policies, it seems clear that the wiser course for the Federation will be to appoint a committee to take up the subject of College Entrance Requirements with the College Entrance Examination Board, to urge upon that board the advisability of appointing committees of secondary teachers, to draft uniform definitions of the various units in mathematics and science, so as to set up definite standards for secondary work in the several subjects.

Such a committee was appointed last year by the C. E. E. B., to draw up a new definition of the unit in Physics. This report was drafted by a committee of six experienced teachers actually engaged in teaching physics, and found no serious difficulty in reaching a united conclusion. This conclusion was at once accepted by the C. E. E. B. and is to go into effect with the examinations of June, 1910.

It is therefore recommended that a committee of three be appointed to take up this matter with the C. E. E. B., and urge upon them the advisability of appointing committees of experienced secondary teachers to draw up such definitions of the various units in mathematics and science as will remove the existing lack of agreement both in formal statement and in actual application.

All of which is respectfully submitted,

W. M. Butler,

Chairman Committee on Policy of Federation regarding College Entrance Requirements.

Report of the committee on a Syllabus in Geometry:

Immediately after the authorization of this committee by the Federation at its meeting in Baltimore, the council began an extended correspondence looking toward the selection of the members so as to fairly represent the various sections of the country, the several associa-

tions in the Federation, and the chief educational interests with respect to the teaching of geometry. This canvass occupied all the spring and resulted in the selection of the following fifteen members of the committee, seven from colleges or universities and eight representing secondary schools:

H. E. Slaught, Chairman, The University of Chicago; C. L. Bouton, Harvard University; F. Cajori, The University of Colorado; H. E. Hawkes, Yale University; E. R. Hedrick, The University of Missouri; H. L. Rietz, The University of Illinois; D. E. Smith, Columbia University; William Betz, East High School, Rochester, N. Y.; E. L. Brown, North High School, Denver, Colo.; Wm. Fuller, Mechanic Arts High School, Boston, Mass.; W. W. Hart, Shortridge High School, Indianapolis, Ind.; F. E. Newton, Phillips Academy, Andover, Mass.; E. R. Smith, Brooklyn Polytechnic Institute, Brooklyn, N. Y.; Mabel Sykes, South Chicago High School, Chicago, Ill.; R. L. Short, Technical High School, Cleveland, Ohio.

Early in the Summer a preliminary organization of the committee was effected and each member contributed in writing a statement of the situation with respect to geometry in the schools as it appeared to him, together with whatever suggestions he desired to make, either as to methods of procedure, reforms to be proposed, purposes in view, results desired, etc. These were manifolded in July and complete copies placed in the hands of all the members, together with a resume of what seemed to be the salient features gathered from all these preliminary suggestions. In this way each member was fully informed of the point of view of each of the others and all were thus prepared to undertake the work with a full understanding of the situation so far as the members of the committee had analyzed it up to that time.

It was then proposed that the committee resolve itself into three sub-committees of five members each to address themselves respectively to the following phases of the work:

(1) LOGICAL CONSIDERATIONS, including axioms, definitions, symbols, new terms, forms of proof, treatment of limits and incommensurables, purpose (whether formal or practical), place in the curriculum, etc., etc.

(2) LISTS OF BASAL THEOREMS, including types of courses as given in various countries, types of courses for different classes of students, *e. g.*, for boys, for girls, for technical students, for college preparation, for non-college preparation, minimum list of theorems for various standard courses, grouping or classification of theorems, etc., etc.

(3) EXERCISES AND APPLICATIONS, including the grading and distribution of exercises, relative importance of algebraic and geometric work, special classes of exercises such as loci problems, correlation with other subjects, such as trigonometry, concrete applications related to drawing, decoration, architecture, ornamental design, mensuration, surveying, machinery, etc., etc.

The membership of these sub-committees is as follows: On logical considerations, D. E. Smith, chairman, William Betz, C. L. Bouton, E. R. Smith, William Fuller. On lists of theorems, E. R. Hedrick, chairman, W. W. Hart, E. L. Brown, F. Cajori, H. E. Hawkes. On exercises and applications, H. L. Rietz, chairman, R. L. Short, F. E. Newton, Mabel Sykes, H. E. Slaught.

These sub-committees have been organized and at work since the opening of the school year, and extensive investigations have already been made in preliminary form. It is proposed to carry on the work of the sub-committees to as great a degree of completion as possible and then to bring the report of their work before the committee as a whole for full consideration, discussion, and action. Not less than a year will be required to bring the work to completion.

In the meantime, the committee finds itself hampered by lack of funds for the prosecution of the work. So far the expenses have been met, for the most part, by the personal contributions of the members. But soon the cost of manifolding preliminary reports will increase, and later the printing of the final report will demand consideration. It would be well if the committee might know at this time approximately to what extent the Federation will back it up in the cost of prosecuting the work.

Respectfully submitted,
H. E. SLAUGHT,
Chairman.

Informal reports were presented from members of the International Commission on the Teaching of Mathematics somewhat as follows:

Mr. C. N. Haskins spoke of the work of the Committee on Technical Secondary Schools.

The work of this committee is divided among three subcommittees:

1. Public, Private, and Corporation Trade and Industrial Schools. Chairman, Professor T. D. Crawshaw, University of Illinois, Urbana, Ill.
2. Commercial Schools, Public and Private. Chairman, Mr. J. E. Downey, High School of Commerce, Worthington Street, Boston, Mass.
3. Agricultural Schools. Chairman, Professor J. E. Ostrander, Massachusetts Agricultural College, Amherst, Mass.

The technical secondary schools are relatively few in number and of relatively recent origin and development. They have arisen to supply a specific educational need not provided for by the general secondary schools (committees III, IV), and in consequence exhibit wide variations of aims, curricula, and methods.

Because of these facts the most important phase of the work of Committee VI must be the study of the variations of the characteristics of these schools from those of schools of the usual type. Difference of object, however, does not necessarily imply difference in methods of mathematical teaching, and it would appear from a preliminary study of the agricultural secondary schools that in this case at least it does not in general actually imply such difference. Consequently it is of great importance to the committee to determine to what extent these schools of special purpose find it possible to use successfully the curricula and methods of the general secondary schools, and the reason why no modification or only slight modification is rendered necessary as a consequence of the special purpose of the schools.

On the other hand many schools have developed distinctive curricula and methods. The questions therefore arise: What are the differences? How are they related to the special purpose of the school? Wherein and why are the methods of the general secondary schools insufficient, and, above all, to what extent have these changes been efficient in improving the instruction in mathematics for the type of pupils attending these schools?

These schools of special purpose are peculiarly exposed to the danger that in them the applications may overshadow the logical and demonstrative element of mathematics. The committee is especially desirous of learning from the teachers in these schools facts concerning their experience in this regard. Does the pupil, in his interest for the immediate application, lose sight of the abstract element, or does the very fact of his familiarity with the concrete application make it easier for him to grasp the underlying abstract theory? It is almost needless to add that if the committee shall be enabled, through the coöperation of the teachers in the technical secondary schools, to report definite facts concerning this problem, based on the actual experience of a large number of teachers, it will thereby contribute in an important way not only to instruction in these special schools, but also to mathematical instruction in general.

The committee therefore bespeaks the hearty coöperation of the corps of instruction of the technical secondary schools, and will be under great obligation to those members of the corps who are willing to aid it by answering its questionaires or in other ways. In particular it will be indebted to those who are willing to contribute discussions, based on experience in their schools, of the various questions which the international commission has proposed in its preliminary report for the guidance of the various committees.

Mr. A. H. Wheeler told of the work of the sub-committee on Teachers' Associations as follows: Professor Gustave LeGras of the College of the City of New York asked me to report to the Federation in his behalf for the Committee on Teachers' Associations including Reading Circles. He wished me to say that the Committee has been gathering material in the form of replies to certain questions and hopes to be able to report to Professor Cubberley in the early part of January.

Since my part of the investigation has been confined to New England I will report in a general way for this section of the country by saying that careful inquiries as to the existence of clubs among teachers of mathematics have been made in all sections of New England, and a few purely mathematical clubs have been located. The Association of Teachers of Mathematics in New England is of course the largest and most important club or association which is purely mathematical. This Association with its branches in Connecticut and Rhode Island is accomplishing great results in stimulating interest and creating new ideals among teachers.

A few of the colleges have reported clubs among the teachers. The most active of these is the M. P. Club, the members of which are connected some with Harvard and some with the Boston Institute of

Technology. This club claims about one hundred and twenty members and reports regular meetings with an active interest. This club has been in existence about twenty-eight years.

There is also the Harvard Mathematical Club, the membership of which includes students at Harvard.

Yale has a mathematical club which claims an existence of about thirty years.

There is also a mathematical club at Brown.

There is a mathematical club at Smith College which is limited in membership and which is intended to give its members an opportunity to discuss original work.

The responses to the inquiries which have been sent out have been very satisfactory and in many cases teachers have indicated that while no clubs exist at present the advantages of such organizations are recognized, and there have been many expressions of desire for clubs among teachers which should be active and which might help to stimulate the members to do better work and to maintain higher ideals along professional lines.

Mr. Wm. E. Stark reported that Committee No. IV has as its field the private general secondary schools of the country including religious schools. The committee proper consists of four members, three of whom act as chairmen of sub-committees dealing with boys' schools, girls' schools, and coeducational schools respectively.

Early last summer an examination of school catalogues and other printed matter was made, leading to the conclusion that practically nothing of value for our purpose could be obtained from this source. The early fall was devoted to the formulation of a questionnaire, to be sent to the directors of mathematics in the private schools. Through the courtesy of the United States Commissioner of Education, a part of the data needed by the committee is to be collected through his office. A general coöperation on the part of teachers of mathematics in private schools in promptly answering the questionnaires is expected.

Mr. E. B. Skinner submitted a report on the findings of the Committee on State Legislation. The report, which was read by title, is as follows:

1. In the Middle West the educational affairs of the states are under the supervision of a State Superintendent of Public Instruction (the title varies somewhat but the office is everywhere similar). This officer is, almost without exception, an elective officer, and is usually elected "at the same time and in like manner as other state officers." Wisconsin and Minnesota are exceptions. In Wisconsin the state superintendent and the district judges are elected in the *spring* and the ballot has the word "nonpartisan" printed at the top. In Minnesota the office is filled by the governor for a two year term.

2. In the Southern States an "Education Board" is the rule. The board is usually made up of the state superintendent, who is an elective officer, together with 366 members appointed by the governor. Sometimes the board is constituted by law of the governor, state treasurer, secretary of state, and attorney-general.

3. The function of the state superintendent is to a very considerable extent that of a statistical or secretarial officer. This is true in nearly all the states North and South so far as I have gone over the school laws. It would be too much to say that they are politicians, but the phrase already quoted, "at the same time and in like manner, etc." which occurs in many state constitutions, looks and sounds ominous.

4. In most of the Western and Southern States, the direct supervision of the "common schools," i. e. the elementary rural schools, is placed in the hands of the *county superintendent*. This officer either alone or with the assistance of a county board issues certificates to elementary teachers. In many states, however, the certification of teachers for city schools is done by the city school board through the city superintendent. In several of the Southern States the county superintendent is appointed, sometimes by a county judge, sometimes by the board of county commissioners or supervisors (i. e. the board that builds bridges, erects court houses, and in general looks after the financial side of county administration), and in one case at least the selection is made by the grand jury. In the language of the law he must be "a person of experience and knowledge in the theory and art of education."

5. In most of the states of the West and South there is a state board of examiners more or less closely connected with the office of state superintendent, whose sole duty it is to look after the certification of teachers. The certificates of the state board are usually for a longer time than those issued by county officers, one class being a life certificate. Almost invariably they cover a considerably wider range of subjects than the county certificates, and usually license the teacher to teach in any public school in the state.

In Arkansas the teacher "must believe in a Supreme Being," and "the examiner will ascertain by *direct question* what the views of the candidate really are." (The italics are my own.)

6. In most of these states the completion of the course of study of certain higher institutions entitles the recipient of a degree to teach in any public school in the state, when the diploma is countersigned by the proper officer, usually the state superintendent. Frequently, as in Wisconsin, such license is valid for one year only, but after the end of a year of successful experience becomes permanent when certified by the proper officer. The institutions whose diplomas operate as a license to teach are frequently named in the state law, more frequently they are designated as "the state university and other institutions maintaining a course of study equivalent to that of the state university, and along with these the state normal schools." Some states, as Minnesota, do not allow mere normal school graduates to teach in the *high schools*, without further preparation, though such candidate may pass the examination of the state board of examiners and thereby become eligible to high school positions. California requires a year of graduate study of its high school teachers.

7. So far as I can learn there is practically no school inspection by state departments in the South. In more than one school code I find the provision, "the state superintendent will visit the schools as often as he can."

8. Only a few of the states in the Central West inspect the *secondary* schools systematically. Wisconsin maintains an excellent and most efficient inspection. A well paid inspector gives his whole time to the work, and he is required by state law to visit every school in the state at least once in two years. I think Minnesota maintains a similar system, but I am not sure.

9. Most of the state universities maintain a system of inspection of those high schools that are "accredited" to the university. The Wisconsin situation is probably typical. This state university has an inspector who devotes his whole time to the work from October 1 to March 1. Besides this officer there are about twenty members of the faculty who devote on the average about two weeks of each year to the work. These men go to the smaller schools singly and to the larger schools in groups of two to four or five, depending on the size of the school. So far as the larger schools are concerned the inspection is *by departments*. The inspection by the state department inspector is made effective by a law that authorizes the department to withhold state funds which are apportioned to all "free" high schools. That of the university inspectors is made effective through the power to withdraw the privilege of sending students to the university. The university inspectors report to a committee on accredited schools. They visit private academies and independent high schools, and even go out of the state to visit schools that ask for the inspection, but do not reach the smaller high schools that can reach up to the measure of the university requirements. There are at present about 80 such in the state.

10. Much friction has arisen among some states through the dual inspection. In one state a resolution was introduced into the state legislature denying the legal right of the university inspector to visit the high schools. In Wisconsin the contest has taken the form of a bill now pending, authorizing the admission to the university of all graduates of all four high schools in the state, thus virtually placing the entrance requirements in the hands of the state superintendent. At the present time the university and the state department have effected an arrangement by which the inspection of either one is reported to the other and is accepted by the other. In this way duplicate inspection is avoided and every school is inspected every year.

11. Historically, the state universities of the Middle West were first in the field as inspectors, in every case, I think. There has been a good deal of charge of "university domination," but not so much I think, as in the East, where the prevailing type is a university on a private foundation, and the usual method of admission has been by examination.

12. High school inspection is in a most interesting stage of development through the Middle West. It is hardly possible that the present status under which a high school may be inspected by a state department inspector, one or more state university inspectors, and two or three privately endowed university inspectors, can endure for long. Strong, fearless legislation will be necessary in most of the states before a solution of the problem is finally effected.

Teaching of Mathematics.

Professor David Eugene Smith, President of the American Commission, was called upon to speak for the Commission as a whole. His message to the Federation is as follows: The speaker said that so much had been written of late concerning the work of the International Commission on the teaching of Mathematics, and so closely connected were several members of this Association and this Society with the movement, that he found himself quite at a loss in attempting to impart any new information as to the inception of the work and the general purposes in view. Nevertheless he felt that a brief resumé of the organization of the Commission may not be out of place, to be followed by a statement of the problems that particularly confront us here in America.

At the fourth International Congress of Mathematicians, held at Rome in 1908, the following resolution was adopted: "The Congress, recognizing the importance of a comparative examination of the methods and plans of study of the instruction in mathematics in the secondary schools of the different nations, empowers Messrs. Klein, Greenhill, and Fehr to form an International Commission, to study these questions and present a general report to the next Congress."

It was by no means a simple matter to effect this preliminary organization. The general idea was popular—if anything too popular, and the plan seemed for a time on the point of failing because of this very fact. The difficulty lay in the selection of the organizing committee, the naming of which on the basis of the countries represented would have resulted in an unwieldy body, and one that would naturally have been selected too hurriedly for the best results. In the closing moments of the session of Section IV, however, there seemed to be a general consensus of opinion that three men were especially fitted to undertake the work of organization—Professor Klein, because of his high mathematical attainments and his great interest in education; Professor Sir George Greenhill, because of his eminence in the field of applied mathematics, and because he represented the country in which the next Congress is to be held; and Professor H. Fehr, because of his position as editor of *L'Enseignement Mathématique*. It was expected that these gentlemen would constitute, in the order named, the President, Vice-president, and General Secretary of the International Commission which they were empowered to organize, and this expectation has since been realized. Their selection was unanimously approved by the Congress in general session, together with the resolution already mentioned.

Among those who have been chosen to carry on the investigation in Germany are Klein, Stäckel, Gutzmer, Treutlein, Schotten, and Shimmack; in France, Saint-Germain, Bourlet, Appell, Borel, Tannery, André, and Laisant; in Italy, Castelnuovo, Enriques, and Scorza; in Austria, Czuber, Suppantschitsch, and Wirtinger; in Hungary, Beke, Rados, Rátz, and Goldziher; in Great Britain, Greenhill, Godfrey, Fletcher; in Russia, Sonin, Kojalovitch, Vogt; in Denmark, Heegaars, Juel, Trier; in Switzerland, Fehr, Graf, Moser—all these being men that stand

among the leaders in their lines. In the United States, there have accepted positions upon the Advisory Council, the president and all of the living ex-presidents of the American Mathematical Society, the president of the American Federation of Teachers of the Mathematical and Natural Sciences, the presidents of Harvard University, Columbia University, and the University of Chicago, and the United States Commissioner of Education. In our country are included in the membership of the various committees and sub-committees many of our best known mathematicians and teachers of mathematics, and here as abroad the best of spirit has been shown towards the work.

The question that naturally arises in considering such a movement is the very ancient one, *Cui bono?* It is a perfectly proper question and it serves the more clearly to fix in the minds of those charged with responsibility, the definite purpose of the investigation.

Before attempting a brief reply, the speaker felt that it was proper to state what is not the purpose, to the end that the real aims may stand forth the more clearly. It is not the purpose of the Commission, nor of any of its members so far as it appears, to pose as a body of reformers. Nothing has yet developed to show that anyone connected with the movement believes that mathematics is more poorly taught than any other subject, or is in more need of reform. No revolution has been advocated, nor has anyone expressed any desire to have the teaching of mathematics to remain stagnant. All articles that have thus far been written in connection with the work show that the members of the Commission desire the same substantial progress in teaching mathematics that is generally found in all other subjects, and no one has taken the attitude of opposition to all that exists, nor has anyone appeared with the dictum that all that is bad and that the new and untried is always good. This general attitude of the Commission, if we may judge by what has thus far been done, will argue for lack of progress with some earnest workers, but it is probable that it will meet with the approval of the substantial leaders in mathematics and in education to-day.

The prime reason for the investigation is unquestionably to be found in the value of an interchange of views and experiences among nations. Why, it may be asked, should the American Association for the Advancement of Sciences, or the American Mathematical Society, or the American Federation of Teachers of the Mathematical and Natural Sciences exist? Why do we need such national gatherings as the present one, and why should we give up our well-earned holidays to attend them? The question seems puerile when applied to such a gathering, for everyone is conscious that he gains much inspiration from such a meeting, and that he returns to his work with a broader horizon because he has been conducted to other points of view. He sees the national problem instead of his narrow local one, and his work is the stronger because of this fact. This, then, is the great *raison d'etre* of the Commission—to act as a clearing house, to let each part of the world see what the other part is doing in the teaching of mathematics. Uniformity is no more desirable nor attainable than uniformity

in dress, in government, or in speech. The movement will tend in this direction, just as all intercourse tends to uniformity in these other lines, but centuries will elapse before any of these results will be reached, if unfortunately they are ever attained.

Such a movement, looking to telling the rest of the world what any specific nation is doing in the teaching of mathematics, carries with it the necessity, on the part of that nation, of taking stock of its own results, and of indulging in a very healthy form of introspection. A second large reason, then, for this investigation, is that we may know not only what the world at large is doing, but also our own aims and curricula and efforts at improvement.

The speaker then proceeded to set forth in detail the topics of investigation by the various committees and sub-committees, and to explain the peculiar nature of the work in the United States.

THE TYRANNICAL POSTULATE.

By Lucy Beales Upham, Boston.

I have just been startled into communicating with School Science and Mathematics by the following:

"Of course there are endlessly many processes going on which have no mental accompaniment, but no conscious mental processes which do not have brain accompaniment. And again we emphasize: all this is not a matter of *mere* observation, but it is a *postulate*, and *just for that reason binding* for everyone who seeks explanation of mental facts." [Italics mine.] Words taken from a book on psychology fresh from the press by a prominent authority.

Here, I think, is contributory evidence of the need of a wider dissemination of the non-Euclidean discoveries. Who that has ever stumbled upon Bolyai and Lobatschevsky and not forgotten the shock, would endow with such compelling power a *mere* postulate? Such a one, of course, could have no quarrel with the assertion, if the word *my* were placed before *explanation*. Indeed, it seems that even a smattering of non-Euclidean ideas may perhaps be the most available means of bringing home to the popular consciousness some conception of the nature of knowledge, by leading to sharper discrimination between what is found in the mind as a result of observation, and of authority, and of deduction from assumption. The vista opens deep of the possible revolution such a keener sense of origins might work in the whole range of human relations.

ARTICLES IN CURRENT MAGAZINES.

American Forestry for February: "The Appalachian Forests," by Hon. Curtis Guild, Jr.; "Forest Problems in the Philippines," by Barrington Moore; "Forestry Beginnings in Vermont," by Austin F. Hawes; "A New Cypress for Arizona," by Geo. B. Sudworth; "The Twenty-ninth Annual Meeting of the American Forestry Association"; "Grazing Leases in Australasia," by A. C. Vetch; "Conference on Education in Forestry;" "The Connection between Forests and Streams," by John H. Finney.

Astrophysical Journal for March: "On a New Mounting for a Concave Grating," Albert Eagle; "The Absolute Wave-lengths of the H and K Lines of Calcium in Some Terrestrial Sources," Charles E. St. John; "Some Photographic Phenomena Bearing upon Dispersion of Light in Space," Herbert E. Ives; "On the Application of the Laws of Refraction in Interpreting Solar Phenomena," J. A. Anderson; "Glass and Metallic Replicas of Gratings," J. A. Anderson.

Bird-Lore for January-February: "The Taming of a Great White Heron," Norman McClintock; "Breeding of the American Crossbill," P. B. Peabody; "An Albino Robin Tragedy," R. W. Hegner; "Photographing a Ruffed Grouse," John Woodcock; "Gull and Cormorants," Miss G. F. Wells; "The Migration of North American Sparrows," W. W. Cooke.

Condor, The, for January-February: "Life History of the California Condor—Part IV, The Young Condor in Captivity," William L. Finley; "Fossil Birds from the Quaternary of Southern California," L. H. Miller; "Abnormal Birds' Eggs," A. M. Ingersoll; "A Defense of Oology," Milton S. Ray; "Some Central Colorado Bird Notes," Edward R. Warren.

Mining Science for January 13: "Rio San Juan of Southeastern Utah," Arthur Lakes. For March 3: "Platinum in British Columbia," Arthur Lakes; "Protection of Mine Timbers from Fungus," John Macoun; "Use of Carbonaceous Filters in Zinc Smelting," C. O. Bannister; "Genesis of Leadville Ore Deposits;" "Gold Mines of France."

Physical Review for February: "The Effect of Temperature upon the Magnetic Properties of Electrolytic Iron," Earle M. Terry; "A Study of the Wehnelt Electrolytic Interrupter," Karl T. Compton; "Magnetization Curves for a Sample of Iron Wire One Mil in Diameter," J. A. Veazey; "An Improved Form of Volumenometer," John Zeleny and L. W. McKeehan; "Electric Wave Receivers," Harold W. Webb and L. E. Woodman; "The Wave-length and Overtones of a Linear Electrical Oscillator," James E. Ives; "The Expansion of Fused Quartz at High Temperatures," H. M. Randall; "Experiments on the Poulsen Arc," William E. Story, Jr.

Plant World for January: "Heredity in Populations and in Pure Lines," L. R. Waldron; "An Interesting Marasmius Fairy Ring," Howard S. Reed; "A New Flora of California," S. B. Paint; "An Animal Factor in Plant Distribution," J. C. Blumer; "Note on Peklo's Work with Mycorhiza," Benj. C. Gusenberg; "The Chemical Organization of a Typical Fruit," A. E. Vinson.

Popular Science Monthly for March: "Insects and Entomologists: Their Relations to the Community at Large," John B. Smith; "The Second Law of Thermodynamics: Its Basis in Intuition and Common Sense," W. S. Franklin; "Climate in Some of its Relations to Man," Robert DeC. Ward; "The Structure of the World-stuff," Horace Clark Richards; "The Relation of the Law to Public Health," Alfred Hayes, Jr.; "International Coinage," Theo. F. Van Wagenen; "The Hubbard Glacier, Alaska," Lawrence Martin.

Psychological Clinic for February: "The Reading Free Dental Dispensary," George S. Schlegel; "Promotion, Retardation, and Elimination," Edward L. Thorndike; "The Restoration of Children of the Slums," Lightner Wilmer.

School World for March: "The Organization of a Large Secondary School" (illustrated), by H. J. Spenser; "Typical Examples in Graphical Constructions—II" (illustrated), by G. C. Turner; "Scientific Apparatus Designed by Teachers" (illustrated); "Practical Domestic Economy Teaching in a Secondary School," by M. A. Cade; "Do We Teach too Many Subjects in the Elementary Schools?—I," by Spurley Hey; "Books for the Geography Lesson."

Sibley Journal of Engineering for February: "The DeLaval Steam Turbine," W. O. Beyer; "Wiring Formulæ," R. W. Krass; "Lightning Protection," B. C. Dennison; "Why Manufacturers Dislike College Graduates," F. W. Taylor.

BOOKS RECEIVED.

The Colorado Mathematical Society. Second Biennial Circular, 1907-1909.

Transactions of the Illinois State Academy of Science, Vol. II, 1909.

The Carnegie Foundation for the Advancement of Teaching. Fourth Annual Report of the President and of the Treasurer, 1909.

Broad Lines in Science Teaching, by F. Hodson, with an introduction by M. E. Sadler, 1910. Pp. 267. New York: The Macmillan Company. Price, $1.25 net.

Academic Examination Papers, for the year 1908-09. New York State Education Dept., Albany. Pp. 383.

Rara Arithmetic, by David Eugene Smith. Edition de luxe, two volumes, 8vo vellum, 500 pp., illustrated, $20 net. Edition in one volume, cloth, $5.50 net.

One Hundred Experiments in Elementary Agriculture for California Schools, by Riley O. Johnson, Head of Dept. of Biology and Nature Study, State Normal School, Chico, California. Third thousand. 42 pp., with notes, 25c per copy.

Course in Nature Study and Agriculture for the Elementary Schools of California, with illustrative lessons, by Riley O. Johnson, State Normal School, Chico, California. Second edition, 8 pp., 10 cents per copy.

The Science of Human Improvement by Better Breeding, by C. B. Davenport. 1910. New York: Henry Holt & Co. Pp. 35.

Agriculture, for Schools of the Pacific Slope, by E. W. Hilgard and W. J. V. Osterhout. 1910. Pp. 428. New York: The Macmillan Company. Price, $1.20 net.

BOOK REVIEWS.

One Hundred Lessons in Elementary Agriculture, A Manual and Text of Elementary Agriculture for Rural Schools, revised by Aretas W. Nolan. 286 pages. Published by The Acme Publishing Company, Morgantown, W. Va.

In "One Hundred Lessons in Agriculture" the author asserts that the "most advanced students of science find the best applications of their knowledge in the fields of agriculture," that the subject gives all pupils a better contact with their environment and better motives for living, that the economic aspects of the subject are of such value in general education that all should at least know of its opportunities to the end that more people may, perhaps, be led to the practice of agriculture; therefore the subject should be included in the curriculum. In order that these hundred lessons and others may be properly taught it is urged that the teacher should have abundant opportunity for experimentation, should collect all sorts of farming materials that can be used in the course, make many excursions with the class to places where good and bad farming may be seen, do his laboratory work with the same exactness that should be done in any other science—in short make a real scientific study of the subject and not merely an attempt to find out how to do a few things that will give an immediate return on the home farm. The topics offered in the exercises, like those of other proposed courses in agriculture, are mainly those that we have been accustomed to use in the courses in botany, zoölogy, and physiography, rearranged with reference to the special applications to farming. The point of view is often botanical, zoölogical, or physiographic, indeed many of the specific experiments are found in courses

in these subjects. The attempt that the author makes is largely to recast old materials into the new subject, and as such presents a good series of experiments, a series that will often prove useful to teachers of botany and zoölogy as well as to teachers of agriculture. It is possible that in some schools there needs to be this organization of the material under the title of agriculture, but those who for some time have been trying to include the applied side of these sciences as a means of giving vital significance to their work will find it difficult to see just what is to be the place of this new arrangement in their schools. The advocates of agriculture often seem to forget that many of the same things that they argue for in their proposed courses are already in the schools. Furthermore, as these things are included in other courses in the sciences they may have a scientific bearing that seems quite impossible when they are separated into the fragmentary treatment of topics that is recommended in agriculture. It should be noted in this connection that some of the most ardent advocates of the teaching of agriculture insist that the subject should be taught after some work has been done in the sciences of botany, physics, etc. It is quite evident that one can get much practical value from the elementary topical consideration of things that are offered for the agricultural course, but such a treatment relates directly to the trade business of farming and not to the science of agriculture, much less to scientific education through use of agricultural and other science materials. It would seem that somewhere between the rather meaningless and formal pure science that too often makes up the high school course and the almost purely applied science recommended for the course in agriculture, should be found the proper materials for science courses.

O. W. C.

Heat, being Vol. IV of An Elementary Text-book of Physics, by R. Wallace Stewart, D.Sc. (London). Crown 8vo. cloth, pp. 246, 84 illustrations; price, $1.50. J. B. Lippincott Company, Philadelphia.

All too frequently the title *elementary* applied to a text-book is a complete misnomer and simply reflects the author's modesty. To this text-book on *Heat* by Dr. Stewart the term elementary is properly applied. He has evidently set out to explain in a simple, logical manner those facts about heat which should be a part of the mental equipment of every educated man, and has succeeded most admirably.

In this country it is a misfortune in arrangement of our elementary courses in science, both in college and in secondary schools, that there is little or no opportunity to give the student an elementary course in physics covering only a single section of the subject instead of teaching what we call "General Physics." For instance, electricity appeals most strongly to boys; heat affords correspondingly large interest to girls as well as boys. This text-book provides just about two or three months' work for an elementary class in college or for a class of juniors and seniors in high school. The student should find it very delightful reading partly because of the simplicity of treatment but particularly because "the flow of thought is natural."

The experiments described are easily understood and many of them are new to readers of American books. They have the additional

charm of simplicity and demand no complicated apparatus. Particular mention should be made of a demonstration of the force of a contracting bar. A steel pin is sheared off as the bar contracts. By introducing alcohol through a dropping funnel into a stoppered bottle which contains the cistern of a siphon barometer, the vapor pressure exerted by the alcohol vapor is directly demonstrated. A bottle fitted with vertical tube is completely filled with a mixture of ice and water. As the ice melts its contraction in volume is seen by the dropping of the water level in the vertical tube. Many other experiments might be mentioned, all of which would appeal to the teacher as quick and vivid demonstrations.

The author introduces some historical material in a very unobtrusive but effective way by referring to experiments by the name of their inventors; for instance, Franklin's experiment on the lowering of the boiling point by decrease of pressure, Bottomley's experiment on regelation, etc.

The dearth of numerical problems would serve as a handicap to many classes; but there is so much to commend and so little to criticise that the book should find a large place in school libraries, and be found a most convenient book of reference where not used as a text.

FRANKLIN T. JONES.

The Study of Nature, by Samuel Christian Schmucker, State Normal School, West Chester, Pa. 315 pages, with 4 colored plates and 54 text cuts. Published by J. B. Lippincott Company, Philadelphia. 1909.

There is a rapidly growing opinion on the part of those who are interested in science education in the high schools that the elementary school science must receive much attention before the best courses may be taught in the high schools. Therefore each new attempt to present nature-study for the grades demands some attention from high school teachers. "The Study of Nature" is one of the newest of these attempts. The book is divided into three sections: 1st. The Theory, 2nd. The Materials, and 3rd. The Course. The first section deals with the usual topics of what nature-study is, its aim and purpose, the teacher's preparation, subjects suitable for nature-study, work in the schoolroom and the equipment of the schoolroom. The second section deals with insects, some water dwellers, the frog and toad, reptiles, birds, domestic animals, wild animals, life of the plant, reproduction of the plant, and the heavens. Section three outlines a proposed course and suggests a list of helpful books. In the theoretical part of the book a good plea is made for indoor work that shall in as large a measure as possible maintain the aspects of out-of-door work. Field work is desirable whenever it can be done, but is much less often possible than sometimes claimed, and may be well substituted in many cases by good indoor work. The desirableness of field work whenever possible is urged, and many of the objections to it are well offset. In general the method of the work is the important thing and the author reminds us of Huxley's fine contention that three things must be present to make the work worth the doing: clear observation,

accurate description, and just inference. It had been well for nature-study if these purposes had been kept more constantly in mind by its advocates. Even the present author gets rather faraway from these primal purposes and speaks at length of high and noble virtues that doubtless may come from nature-study as from any other good school work, virtues which while of the greatest importance to the world, are secondary in the order of their appearance, and indeed do not come at all unless clear observation, accurate description, and just inference have been made upon something that is within the reach of the pupil. That "pious aspiration," "enrichment of life," "establishment of firm character," and a "reverent attitude toward the great Power about us" are "the highest attainments that the school can bring," we probably should agree fairly well. But these are virtues that we hope to secure from all our education, and we expect to secure them by careful attention to the things that Huxley urged us to keep in mind, rather than by assuming as direct and immediate purposes such general and universally sought virtues. In the materials section of the book 113 pages are given to animals, 45 to plants, and 9 to "the heavens." Physical nature-study and climatology receive no attention, a failing noticed in most nature-study books. It must be kept in mind that the author later outlined work for the first four grades and places some physical nature-study therein, but it is small in amount, and notably absent from the "materials" section of the book. The treatment of plants is extremely brief, and that given to the heavens, while consisting of but nine pages, consumes a considerable part of those with the meaning of the old signs of the zodiac, some of which are figured for the benefit of those who have not seen an old-fashioned almanac. In speaking of the significance of some of the fantastical features of these old figures the author says: "At first sight it may seem absurd and even silly to carry this likeness to such extremes, but if it is not too soberly done and is handled in proper spirit, it will certainly help to fix the features in the children's minds, etc." Would not clouds, rain, snow, hail, the seasons, day and night, winds, and climate in general be much more interesting, more valuable and susceptible to elementary scientific treatment than the materials offered above? It is just such things as those offered above that have estranged many important interests from the nature-study movement. Materials ready at hand, within the every-day experiences of the children, real nature materials are so much better if dealt with as natural—not unnatural or mythological materials —that it seems too bad to offer questionable materials at any time under the guise of nature-study. It must be said that this criticism holds for but a very small part of the book in question. Indeed, in the lessons outlined the author includes a much wider and better range of topics than his discussion of materials would suggest. The course outline for the first four grades will prove helpful to a good many teachers. It treats topically of things that are usable in the different grades, giving a paragraph to each topic. For example, in the fall term in the third grade the topics are the English sparrow, toadflax or nasturtium, the fish, the pear, the temperature, the mistletoe.

O. W. C.